PB-216 938

DEVELOPMENT OF TECHNIQUES FOR MULTI-PURPOSE MANAGEMENT OF REUSABLE WATER BEFORE IT ENTERS THE GREAT SALT LAKE

Don M. Rees, et al

Utah University
Salt Lake City, Utah

February 1966

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WP00027

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UNIVERSITY OF UTAH
INSTITUTE OF ENVIRONMENTAL BIOLOGICAL RESEARCH
SALT LAKE CITY, UTAH 84112
COOPERATIVE RESEARCH PROJECT

Report No. 4 Terminal

February 1966

MULTIPURPOSE MANAGEMENT OF REUSABLE WATER IN UTAH

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Prepared by

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NIH RESEARCH GRANT NUMBER WP-00027
TASK FORCE PROJECT V

REPORT NO. 4 TERMINAL

COMPLETED FEBRUARY 1966
COVERING PERIOD SEPTEMBER 1, 1961, TO AUGUST 31, 1965

TITLE

DEVELOPMENT OF TECHNIQUES FOR MULTI-PURPOSE MANAGEMENT OF REUSABLE WATER BEFORE IT ENTERS THE GREAT SALT LAKE

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This project was supported, in part, by funds provided by Research Grant WP-00027, Department of Health, Education, and Welfare, Public Health Service, National Institutes of Health, Research and Training Grants Branch, Division of Water Supply and Pollution Control.

Details of illustrations in
this document may be better
studied on microfiche

FOREWORD

Problems involving legal ownership and the multipurpose use of available water on the eastern shores of the Great Salt Lake have been in existence for more than a century. These problems are currently increasing proportionately with the recent rapid increase in the human population in this area and as a result are becoming more controversial and acute.

In an attempt to assist in improving multipurpose use and management of the reusable water in this area this cooperative research program was established. The legal ownership of the water is not included in this study.

The study was conducted for four years from September 1, 1961, to August 31, 1965, as a cooperative effort and was supported, in part, by Water Supply and Pollution Control research grant WP-00027. A "Task Force" functioning under the subcommittee on Vector Control of the Interagency Committee on Water Resources proposed the study and recommended support.

The principal investigators are associated with the University of Utah and seven federal and three state agencies, two privately owned companies and numerous individuals are actively participating as collaborators.

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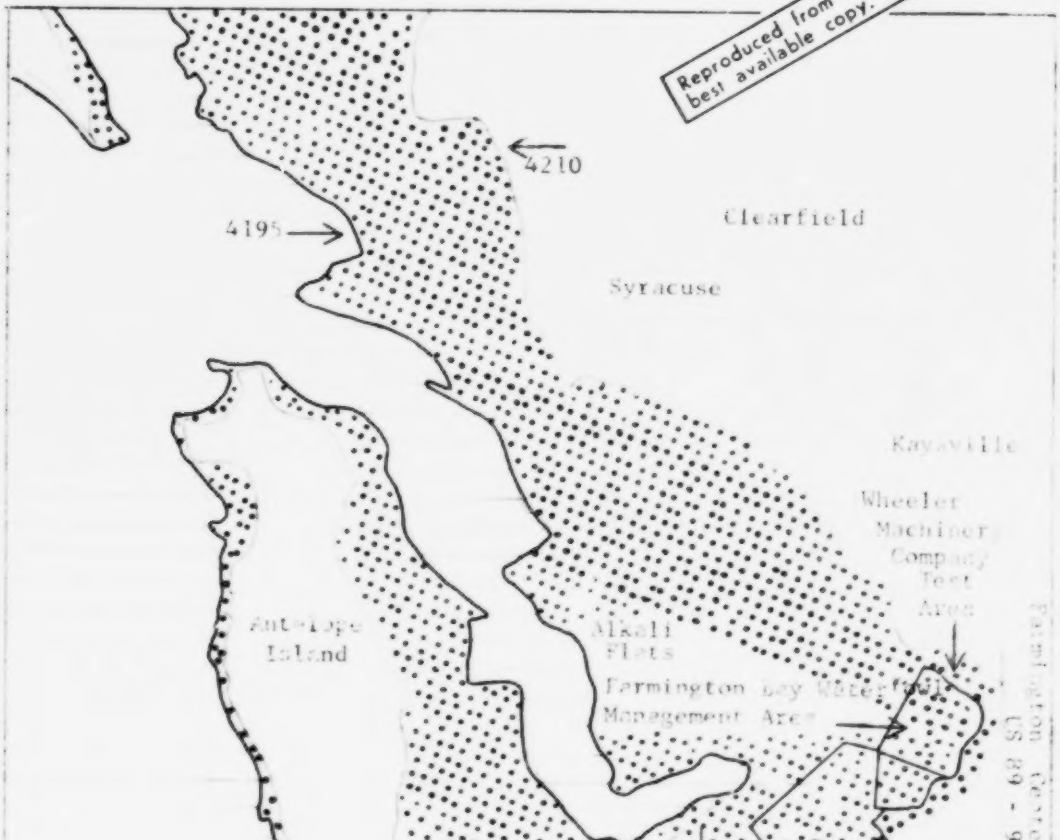
ACKNOWLEDGEMENTS

We hereby acknowledge and express our appreciation to the Subcommittee on Vector Control of the Interagency Committee on Water Resources for support and assistance in planning and conducting this research program. Thanks and appreciation are extended to Research and Training Grants Branch, Division of Water Supply and Pollution Control, Public Health Service for the funds that made this four year cooperative study possible. We also acknowledge the support and assistance received from the personnel of the following collaborating agencies which have contributed so much to the measure of success achieved as a result of this study: Agricultural Research Service, Soil Conservation Service, Weather Bureau, Public Health Service Disease Ecology Section, Fish and Wildlife Service, Geological Survey Surface Water Branch, Bureau of Reclamation, Utah State Department of Health, Utah Office of State Engineer, Utah Mosquito Control Association, Salt Lake City, Salt Lake County and Davis County Mosquito Abatement districts, Utah Mosquito Control Fish and Wildlife Management Coordinating Committee, West Side Associated Gun Clubs, Lake Front Gun, Fur and Reclamation Club and Wheeler Machinery Company. In addition we hereby acknowledge and express our appreciation to the many members of the faculty and students of the University of Utah, Utah State University and Brigham Young University and to all who have contributed in any way to the success of this cooperative effort. We express our appreciation to the news agencies who have helped to publicize the results of this study. To all we are sincerely grateful for any assistance rendered.

DMR
FDA
DMA
GCC

Fig. 1. Location of Study Areas

Reproduced from best available copy.


4210
Clearfield
4195
Syracuse
Kaysville
Wheeler Machinery Company Test Area
Antelope Island
Alkali Flats
Farmington Bay Waterfowl Management Area
Farmington Centerville Bountiful
US 89 - 91
Lake Front Gun Club
State Canal
Gun Club Marsh Area
Jordan River
Great Salt Lake
Surplus Canal
4210
Coggin Drain
Air port
4195
US 40
Salt Lake City
U S 40
0
6
Scale in Miles

DEVELOPMENT OF TECHNIQUES FOR MULTIPURPOSE MANAGEMENT OF REUSABLE WATER BEFORE IT ENTERS THE GREAT SALT LAKE

I. INTRODUCTION

In Utah, on the eastern shores of the Great Salt Lake, a perplexing problem exists concerning the determination and application of the most desirable, productive and beneficial use of available reusable water.

The problem is perplexing because legal ownership of the water has not been determined, the water supply during certain seasons does not meet the demands, the water quality and quantity is extremely variable, and priority of the proposed and current multipurpose use of this water has not been established. In addition the water management techniques to attain the most effective beneficial results in most of the programs have not been ascertained.

The proper application and management of this "reusable water" is of considerable importance to the people of Utah, particularly those directly concerned with its use in tangible economic returns, the recreational values and the public health aspects. The situation is significant as 70% of the human population of the state live adjacent to this problem area and the problem is becoming increasingly acute as a result of the current rapid growth in this population center.

It is apparent that some of the current water management practices or neglect in managing the water along the lake shore, is responsible for the production of great numbers of pest and potential disease transmitting mosquitoes, gnats, horseflies, deerflies and other noxious insects. It is assumed that the development of waterfowl marshes has at times resulted in the production of mosquitoes and other noxious insects which could have been prevented had insect abatement measures been included in the marsh development plans. The mismanagement of water used for irrigation, particularly on pastures, has created prolific mosquito production and in some instances with detrimental effects on the intended crop.

It is generally recognized that there is a need for more information demonstrating the relationship between the production of mosquitoes and other insect pests and disease vectors and planned multipurpose water management techniques and practices. This information should include the necessary requirements for waterfowl, agricultural crops, public health measures and other beneficial uses of the land and water involved.

Objectives of the Present Study: To develop and field test physical facilities techniques and management practices for multipurpose use of reusable water on the eastern shores of the Great Salt Lake which will provide the greatest mutual benefits to public health, agriculture, fish and wildlife and other interests concerned.

II. DESCRIPTION OF THE AREA

Along the eastern shores of the Great Salt Lake there is a strip of land varying from 2 to 18 miles in width and about 55 miles in length which as recent as 1872 was covered by the water of the Great Salt Lake. This ground, located at elevations between 4195 feet above sea level, the present lake level, and 4210 feet the 1872 level, includes approximately 510 square miles. The average gradient towards the lake is one foot per mile. The soils are very strongly impregnated with salts including alkali salts. Restricted drainage, ponded water and high sub-surface water levels retain the alkali salts on or near the soil surface. The soils range from a silt loam to a heavy silty clay and water and air movement through them is greatly retarded. Wherever water other than water from the lake is available, the land is being developed primarily as marsh for wildlife, principally waterfowl and muskrats, and as pasture for domestic livestock or both. Within this area are five waterfowl management areas operated by the Utah State Department of Fish and Game, one Federal migratory bird refuge, numerous privately owned and operated gun, fur and reclamation clubs, and one Bureau of Reclamation water storage project.

Adjacent to this land, between elevations 4210 and 4215 feet above sea level are lands used primarily for agricultural purposes. Approximately 47 square miles of this land is now being reclaimed by drainage and an additional 9 square miles of irrigated land is in need of drainage.

The water entering into the study areas has been designated "Reusable Water" rather than "Waste Water" since most of this water can be beneficially used and reused. This water comes from streams originating in the mountains, run-off from irrigation, storm gutters and sewers, seepage from canals, effluent from sewage treatment plants, and flowing wells and springs. If not checked in its course, this water would flow by the most natural route into the Great Salt Lake. The prior use of this water often impairs its quality and the beneficial reuses are restricted by this impairment. As it passes through agricultural land, the water increases in salinity. Organic matter and bacteria are added from municipal and industrial wastes.

The water quantity entering the study area varies both on a yearly and a seasonal basis. The water in the Jordan River, the major source of water to the study areas, varies from a daily mean discharge per month of 172 cubic feet per second in February 1963, to 614 cubic feet per second in June, 1964. The water in the Surplus Canal has varied from 0 to 1070 cubic feet per second.

The climate of the study area is that of a cold desert with an average precipitation between 13 and 14 inches per year. Most of the precipitation falls in the winter months in the form of snow. The summer temperatures are hot with a monthly mean of 76.4 F. in July and the winters are cold with a monthly mean of 28.2 degrees F. in January.

The vegetation on the high ground adjacent to the marsh impoundments is limited to those forms which are both drought and salt tolerant. It consists mainly of greasewood (Sarcobatus vermiculatus (Hook) Torr.) and several species of weeds and grasses.

Nearer the impoundments pickleweed (Allenrolfea occidentalis (Wats.) Kuntze), salicornia (Salicornia spp.) and salt grass (Distichlis stricta (Torr.) Rybd.) are dominant. A variety of salt tolerant emergent, submergent and floating vegetation is found in the impoundments. Complete vegetation lists are presented in Appendix Table 16.

In this strip of land three sites were selected as study areas:

1. The Lake Front Gun, Fur and Reclamation Club located in Salt Lake County, northwest of Salt Lake City. This club is privately owned, with a limited membership of 60 shares. It includes a total of about 5,000 acres of which approximately 1,500 acres are flooded during the mosquito season. The size and location of the flooded areas vary seasonally and yearly depending largely on available water. There are approximately eight miles of dikes enclosing seven units in which the water is managed. The primary source of water for this club is the Surplus Canal which diverts water from the Jordan River (see map on Page 4).

2. The Farmington Bay Waterfowl Management Area is under the jurisdiction of the Utah State Department of Fish and Game and is used extensively by the public for hunting waterfowl. It consists of approximately 10,000 acres of impounded water, marsh, and upland habitat adjacent to the Great Salt Lake and located in Davis and Salt Lake counties. Eighteen miles of dikes have been constructed and the area is divided into four large units. The primary source of water is the Jordan River via the State Canal (see map on Page 4). Other water sources are Farmington Creek, Rick's Creek, Parrish Creek, Centerville Creek, Stone Creek, Mill Creek, effluent from a sewage treatment plant, irrigation runoff, and overflow from adjacent marshes. The amount of water entering Farmington Bay varies considerably seasonally and yearly. The elevation of this site ranges from 4195 to 4208 feet above sea level.

3. The Wheeler Machinery Company Test Area is located in Davis County north of and adjacent to Farmington Bay Waterfowl Management Area. This land was purchased for the purpose of testing heavy construction equipment and in the process is being developed for agriculture and wildlife use. At the time of purchase, the property consisted of approximately 800 acres of very irregular, unimproved, low grade pastureland, old salt water evaporation ponds and marshes vegetated with grass and emergent vegetation.

During the equipment testing process extensive land-leveling has been accomplished. Waterways and water storage facilities, including water management structures, have been constructed for use in the irrigation of pasturelands and other areas suitable for agricultural pursuits and for the development of approximately 300 acres as a wildlife wetland area.

The water sources for the Wheeler site are three small creeks, the largest of which is Farmington Creek. The elevation of the Wheeler Area is 4205 to 4215 feet above sea level.

The location of the study areas, their relationship to the Great Salt Lake and old lake bed and their proximity to populated areas are shown on the map on Page 4.

The methods of procedure used in making this study are presented in the appendix Page 37.

III. PRESENTATION AND ANALYSIS OF DATA

A. Soils: According to the Soil Conservation Service

Soils on the Lake Front Gun Club: (The Roman numeral with each soil type refers to land capability classification of the Soil Conservation Service (Rockensmith 1950).

IVs. Leland silt loam (LiH). These are deep brown soils with strongly salt and alkali affected subsoil. Plants that draw their moisture and nutrients from deep within the soil must be salt and alkali tolerant to grow under these conditions. The surface layer is a silt loam and the subsoil a silty clay loam. A whitish lime layer occurs in the subsoil. Water and air movement through the soil is slow. With application of irrigation water the alkali salts could be moved down in the soil, but complete reclamation is not possible due to the restricted drainage. The Leland soils occur on the elevated areas and are not subject to flooding. Slopes are from 0 to 1%.

VIIs. Jordan silt loam (JlB). This soil is similar to the Leland silt loam except the subsoil of the Jordan silt loam is a heavier silty clay and the slopes are undulating and vary from 1 to 3%. The very slow water movement makes it very difficult to move the alkali salts farther down into the soil. The Jordan soils occur on the elevated areas and are not subject to flooding.

VIIs. Alluvial sand, sandy (A-6). These are deep, dark grayish brown soil materials with a loamy to sandy surface layer and a silt clay loam subsoil. The subsoil is very strongly affected with salt and alkali. The sand size particles are very fine lime concretions made up mostly of calcite. Water and air movement is slow. Leaching with irrigation water will move the alkali salts lower into the subsoil but the restricted drainage will not allow complete reclamation. These lands occur at higher elevations and are not subject to flooding. Slopes are undulating and vary from 1 to 3%.

VIII. Saltair soils (SaA). These are deep silty clay or silty clay loam lake laid sediments with a loam or silty clay loam surface, very strongly affected with salt and alkali. A salt crust occurs on the surface. Thin lenses of very fine sandy loam occur between the finer layers. The surface is light gray and the subsoil brown with mottles. Water and air movement is slow. The Saltair soils are subject to the extremes of ponded water to the very dry periods where large cracks develop. The soils are often barren and only the most salt and alkali tolerant plants can grow where runoff water flushes across. They occur on the smooth gently sloping old lake bottom adjacent to the present lake level.

Class IV land is fairly good land that is best suited to pasture and hay, but which can be cultivated occasionally--usually not more than one year in six. Careful erosion prevention practices must be used when it is cultivated.

Class VII land is suited for grazing or forestry with extreme care to prevent erosion or other damage. Usually too steep, rough, shallow or dry to be seeded to grass.

Class VIII land is suited only for wildlife, recreational or watershed purposes. Usually it is extremely steep, rough, stony, sandy, wet, or severely eroded, e.g., rocky foothills, marshes, coastal sand dune areas, etc.

All of the soils on the Lake Front Club are strongly affected by salt and alkali and restricted drainage limits their use.

Soils on the Wheeler Machinery Test Area:

II V1, W4. These are deep, dark gray, silt loam soils with a strong lime zone at 16 - 48 inches. The water table is within 36 - 60 inches of the surface during much of the growing season unless a drainage system is functioning. Water and air move through the soil at a moderate rate; water and fertility holding capacity is high -- 2 inches of water per foot. Slopes are undulating with a general grade of 0 - 1%. Leveling is expensive because of the strong undulating surface.

II V1s3, W4. These are deep, dark gray, salt and alkali affected soils with a silt loam surface and a silty clay loam subsoil. A whitish lime zone is found at 19 - 32 inches. The water table is found within 36 - 60 inches of the surface unless a drainage system in functioning. Water and air movement through the soil is slow. Water and fertility holding capacity is high -- 2.2 inches of water per foot. The land is undulating with a general slope of 0 - 1%. Land leveling is expensive.

VI W4. These are deep, dark grayish brown, salt and alkali affected, very fine sandy loam soils. A whitish lime layer is found in the subsoil. Water and air movement is moderated and water and fertility holding capacity is good, retaining about 2 inches of water per foot.

These soils occur just above the Great Salt Lake Plain and the land is broken by meandering channels. The water table is within 20 - 26 inches of the surface most of the time. These soils must be drained in order to leach the salt and alkali out and keep it out. There is sufficient fall to the lake plain in this area for drainage purposes. The land is strongly undulating with a general grade toward the lake of 0 - 2%. Land leveling on the area requires heavy cut and fill and is very expensive. It may be necessary to drain before a complete leveling job can be done. This land is best suited for permanent pasture or hay.

VII W4. These are deep, poorly drained, gray silty clay loam soils. They are strongly affected by salt and alkali. They are located adjacent to the lake plain. They are limited to restricted grazing or wildlife (waterfowl) area use. The land is strongly undulating with a general slope of 0 - 1%.

VIII. These are deep, poorly drained, gray silty clay loam soils. They are strongly affected by salt and alkali. They occur on the flat lake plains of the Great Salt Lake. Vegetation is scarce or void. Slopes are from 0 - 1%. They are best suited for wildlife areas.

Lands with class II, III, and VI soils are being leveled, drained, and developed for agricultural purposes. Lands with class VII and VIII soils are to be developed for wildlife areas.

B. Water:

1. Quality

Summaries of water quality data from the study areas and from streams entering into the study areas, are included in Appendix Tables 21, 22, 23 and 24. These data include ion analysis, salinity measured in electrical conductivity, alkalinity measured in sodium absorption ratio, 5 day biochemical oxygen demand (BOD), pH and most probable number of coliform organisms (MPN). The waters have been classified by use of conductivity, alkalinity, BOD, and MPN data. An explanation of these classes is contained in the Appendix Table 20.

All water samples taken from the Lake Front Gun Club were rather highly saline, being in class C_3 or C_4 with the mean from each sampling site in class C_4. The sample means for sodium absorption ratio ranged from 5.4 to 12 establishing a class from S_2 to S_4. These waters are of rather low quality and any plants using these waters must be quite salt or alkali tolerant. Most of the water samples were within the limits of class "C" water for BOD and MPN determinations.

On the Wheeler Test Area water from all four sampling stations was of good quality chemically and can be used for irrigation of plant and for fish and wildlife use with few limitations. All of the samples were within the limits of class "C" water for BOD and MPN determinations.

The water samples taken from Farmington Bay Waterfowl Management Area were rather highly saline and alkaline and were of low quality chemically. Most of the water samples taken at the south end of Farmington Bay exceeded the limits of class "C" waters for BOD and MPN determinations. This sampling station is located about one-half mile below the effluent outfall of a sewage treatment plant. The samples taken at the north end of Farmington Bay, after the water had passed through a series of marsh ponds, was of better quality and was largely within the limits of class C water.

Samples taken from the Jordan River and Surplus Canal, the major streams entering into the study areas, show these waters to be rather high in salinity but generally low in alkalinity. The BOD and MPN coliforms were often quite high especially in the regions of sewage treatment plant effluent outfalls.

More detailed data on water quality in the study areas are presented in Annual Reports 2 and 3 (Rees *et al*, 1963, Rees *et al*, 1964).

2. Quantity

Summaries of flows of streams entering into the study areas are given in Appendix Tables 18 and 19.

The principal water supply for the Lake Front Gun, Fur and Reclamation Club and the Farmington Bay Waterfowl Management Area is the Jordan River. The Surplus Canal diverts water from the Jordan River at 2100 South, Salt Lake City, and provides water for agriculture and marsh areas including the Lake Front Club. The North Point Canal and the Goggin Drain divert water from the Surplus Canal. The Jordan River provides water for agriculture and marsh lands including Farmington Bay via the State Canal. The Jordan River receives water from storm sewers from Salt Lake City and the down stream flow readings are generally higher than the upstream flow readings despite diversion of water for irrigation (compare 2100 South measurements with Cudahy Lane measurements).

In addition Farmington Bay receives water from several creeks along the Wasatch Front in Davis County. Water available from these streams is negligible during the summer months because it is diverted for irrigation purposes.

The quantity of water entering into the study areas varies considerably both seasonally and yearly. During the four-year study the Surplus Canal varied from a mean daily flow of 116 cubic feet per second in the water year 1962-1963 to 222 cubic feet per second in 1964-1965. The minimum flow in the Surplus Canal during this four-year period was 0 and the maximum 1070 cubic feet per second. Similar variations are found in the other streams.

The periods of maximum flow are generally in May and June corresponding to the periods of spring precipitation and to the periods of runoff from the melting snow on the adjacent watersheds. The periods of minimum flow vary sometimes coming in the summer months of July and August and sometimes in the winter months.

The seasonal and yearly variation of water quantity results in a seasonal and yearly fluctuation of water levels in area and depth on the marshes. The general pattern of this fluctuation is a high water level in the spring and early summer, a decrease during the summer and high levels again in the fall. The area flooded from year to year varies especially during the dry summer months. During 1965 a much higher water level (area and depth) was maintained than in the previous years of this study.

Complete stream flow data are published by the Geological Survey (U.S. Dept. of Interior, Geological Survey--1961, 1962, 1963 and 1964).

C. Mosquitoes

Mosquito larvae collected in the three study areas were *Aedes dorsalis* (Meigen), *Culiseta inornata* (Williston), *Culex tarsalis*

Coquillet, Culex erythrothorax Dyar and Culex pipiens Linnaeus. Larvae which were originally identified and reported as Culex salinarius Coquillet were collected from all three areas. This identification is now questionable. In 1965 Aedes fitchii (Felt and Young) were collected in the agricultural part of the Wheeler Machinery Company Test Area.

A summary of larval collections made in each sampling station during the four-year study is presented in Appendix Table 1 and 2. It is evident from these larval collection records that Aedes dorsalis, Culiseta inornata, and Culex tarsalis are generally abundant and widely distributed throughout the study areas while the other three species are usually less abundant and more restricted in distribution. In 1965 Culex erythrothorax larvae, as a species, were much more abundant and widely distributed than in the previous three years.

Appendix Table 3 contains the total number and the percentages of each species of mosquito larvae collected in each of the sampling stations. On Farmington Bay and the Lake Front Club, C. inornata larvae were the most numerous, A. dorsalis second, followed closely by C. tarsalis, and more distantly by C. erythrothorax and C. pipiens. On the Wheeler property, A. dorsalis larvae were the most numerous, followed closely by C. tarsalis and more distantly by C. inornata, C. erythrothorax, A. fitchii and C. pipiens. Culex erythrothorax was quite low in numbers except in 1965 when it accounted for 40 percent of the larvae collected on the Lake Front Club.

Appendix Table 4 compares the larval densities measured in average numbers of larvae per dip in each sampling station by week and year. Sampling Station 1 on the Lake Front Gun Club was highest in mosquito production except in 1964. Station 8 was highest on Farmington Bay except for 1962. The most productive station on the Wheeler Area changed each year.

Appendix Table 5 contains a larval index compiled from the mosquito density measured in average number of larvae per dip and the size of the area involved in mosquito production.

Adult mosquitoes collected in the study areas were Aedes dorsalis (Meigen), Aedes nigromaculis (Ludlow), Aedes vexans (Meigen), Culiseta inornata (Williston), Culex tarsalis Coquillet, Culex erythrothorax Dyar, Culex pipiens Linnaeus and Anopheles freeborni Aitken. Aedes nigromaculis, A. vexans, and A. freeborni were not collected in the larval stages in the study areas. The study areas are obviously within flight range of the larval habitats of these three species.

Appendix Tables 6, 7, and 8 contain weekly comparisons of light trap, bite count, and car-top trap collections for the four-year study period.

Light Traps

In the three New Jersey type light traps operated twice each week, C. tarsalis was the most numerous in the Farmington Bay and Kaysville light traps except in 1965 when C. erythrothorax was the most abundant mosquito collected in the Farmington Bay trap. Culiseta inornata was the most numerous mosquito collected at the South Davis County Sewage Treatment Plant.

Biting Counts

Aedes dorsalis was the most numerous mosquito taken in each station in biting counts except in 1965 when C. erythrothorax outnumbered A. dorsalis in bite count collections made on the Lake Front Gun Club.

Car Top Trap

Car top trap collections were made only in 1965 and C. erythrothorax was the most numerous mosquito taken in these collections.

Appendix Table 9 presents a summary of all mosquitoes collected by all methods for the four-year period.

D. Wildlife:

Lists of birds, mammals and fish found in the study areas are found in Appendix Tables 11, 12 and 13.

Of the 140 species of birds found in the marsh areas, 37 species, mostly waterfowl, are game birds. A summary of the waterfowl bag checks made on Farmington Bay by the State Department of Fish and Game is made in Appendix Table 14.

The results of the wildlife survey are included in Appendix Table 16. Eight species of ducks were found nesting the study areas. The highest nesting densities were found in Station 8 on the Lake Front Club with 5 successful nests per acre and on Station 7 on Farmington Bay with 5.2 successful nests per acre. Station 8 on the Lake Front Club is characterized by a dense growth of olney's bulrush with fairly deep water while Station 7 on Farmington Bay is a mixture of salt grass and alkali bulrush with very shallow water.

Twenty nine species of mammals are reported from the study areas. The muskrat is trapped extensively for its fur on both the Lake Front and Farmington Bay Areas. The number of muskrats trapped over a five-year period on Farmington Bay is presented in Appendix Table 15. In 1965, 1960 muskrats were trapped on the Lake Front Club bringing an income of $1950.00 for the furs.

Seven species of fish were identified from the study areas. Large numbers of carp are found in the marsh ponds. These fish are undesirable in that they destroy food which could be utilized by the waterfowl but they are utilized to some extent by bow and arrow hunters and by commercial fishermen who take them for fertilizer, fish food and human consumption.

E. Agriculture

Agricultural developments have progressed satisfactorily on the Wheeler Machinery Company Test Area in conjunction with the extensive testing of heavy earth moving equipment.

Fields which have been leveled and planted have resulted in fair yields of forage crops. Planted areas are watered with movable sprinkler irrigation systems, the water being drawn from five storage reservoirs.

The agricultural activities on this property have not been underway a sufficient length of time to accurately assess their value; however, results thus far have been very encouraging.

As a result of the water management practices now in use and planned for the immediate future this project continues to provide excellent opportunities for further investigation of land development for agriculture and waterfowl units with a minimum of mosquito production.

F. Other Projects

Weather

A summary of weather data for 1962-1965 including temperature and precipitation is presented in Appendix Table 25 . This data was obtained from the U.S. Weather Bureau Monthly Meteorological Summaries, Airport Station, Salt Lake City, Utah. The total precipitation was higher in 1964 and 1965 than in 1962 and 1963. This higher precipitation made more water available for the marsh areas during these two years. In 1965 the precipitation remained above normal during the entire summer and reduced the drawdown of water in the marshes during the mosquito season. This accounted for the increase in mosquito production on some of the sampling stations during 1965.

A summary of weather data for 1964 and 1965 from the Farmington Bay Evaporation Station is presented in Appendix Table 26 . This data includes air and water temperatures, wind and amount of evaporation. The computed evaporation is an estimate of the actual evaporation from a lake or marsh surface. This data was obtained from the U.S. Weather Bureau, Hydrology Section, Salt Lake City, Utah.

In 1964 the peak evaporation in this area was 7.68 inches in June. In 1965 the peak evaporation occurred in August with 6.619 inches. Since the total evaporation for an area is dependent in part on the surface area, a decrease of the surface area through confining and deepending the water would decrease the amount of water lost from the marshes by evaporation.

Biting Tabanidae

The biting horseflies and deerflies create a serious annoyance for wild animals, domestic livestock, and man on the marshlands and the inhabitants in nearby residential areas. Tabanids are also known vectors of tularemia and possibly transmit other disease organisms of man and animals in this area.

The following species of Tabanidae are prevalent on these marshes and are listed according to their relative abundance:

Deerflies:

Chrysops discalis Williston and *Chrysops aestuans* Van der Wulp.

Horseflies:

Tabanus punctifer Osten Sacken, *Tabanus lineola* Var. *scutellaris* Walker and *Tabanus productus* Hine.

The oviposition sites for the tabanids are above the water level on vegetation or other objects in or overhanging the water. Egg clusters were found on the following types of vegetation:

Greasewood	*Sarcobatus vermiculatus* (Hook) Torr.
Pickleweed	*Allenrolfia occidentalis* (Wats) Kuntze
Tamarisk	*Tamarix pentandra* Pall.
Salt Grass	*Distichlis stricta* (Torr.) Rhbd.
Common Cattail	*Typha latifolia* L.
Narrow Leaf Cattail	*Typha angustifolia* L.
Olney's Bulrush	*Scirpus olneyi* A. Gray
Hardstem Bulrush	*Scirpus acutus* Muhl
Alkali Bulrush	*Scirpus paludosus* A. Nels.

The eggs hatch and the larvae drop into the water and burrow into the mud where they develop. They pass the winter in the larval stage. In the spring and summer they pupate in moist soil not covered with surface water. From these areas the adults emerge.

Crops:

The germination and emergence of the wild millet planted on the Lake Front Gun Club in 1964 was poor. This was probably due to a failure in the irrigation system. In 1965 Japanese millet was planted and the success was much better although the crop produced only a fair yield. The white sweet clover planted on the dikes was successful especially in the second year and is rapidly becoming established. The tall wheat grass planted was less successful but has become established on some of the dikes.

Japanese millet planted on the North Point Gun Club was fairly successful but the planting was not repeated in 1965.

Japanese millet planted on the Farmington Bay Waterfowl Management Area was very successful in limited areas in 1964. The crop on these areas was extensively utilized by waterfowl and upland game birds. The 1965 crop on Farmington Bay was damaged by an early frost. Tall wheat grass has been very successful in this area and is used extensively by upland game birds. Yellow and white sweet clover has become well established on many of the dikes at Farmington Bay.

Encephalitis Surveillance:

None of the blood samples taken from the two sentinel chicken flocks over the three-year period showed the presence of antibodies for Western Equine Encephalitis or St. Louis Encephalitis virus.

IV. DISCUSSION

A. Correlation Between Waterfowl Habitats and Mosquito Production.

Figure 2 presents a profile of a composite waterfowl marsh in the study area. The marsh is divided into the following zones according to vegetation: 1) upland, 2) moist soil, 3) emergent, 4) submergent and 5) floating aquatic vegetation. As a result of the flat topography and accompanying fluctuation in the extent of the water surface, these zones are often broadly overlapping. These zones are much narrower and more distinctly delineated on steeper slopes such as the dikes.

Not all parts of the marsh are mosquito producing and not all areas which produce mosquitoes are equal in productivity. Vegetated areas from which water is repeatedly removed and reflooded are highest in mosquito production especially of A. dorsalis, a flood water mosquito which is a vicious feeder on man and other animals and migrates many miles.

Shallowly flooded vegetated areas are highly productive of Culex and Culiseta species, the more permanent water mosquitoes, if the water remains for two weeks or more when climatic conditions and other requirements are suitable. These fluctuating and shallow water areas are generally characterized by salt grass, a moist soil vegetation. This salt grass zone is suitable for nesting for waterfowl if it is not flooded during this period. Unless it is flooded there is no mosquito production.

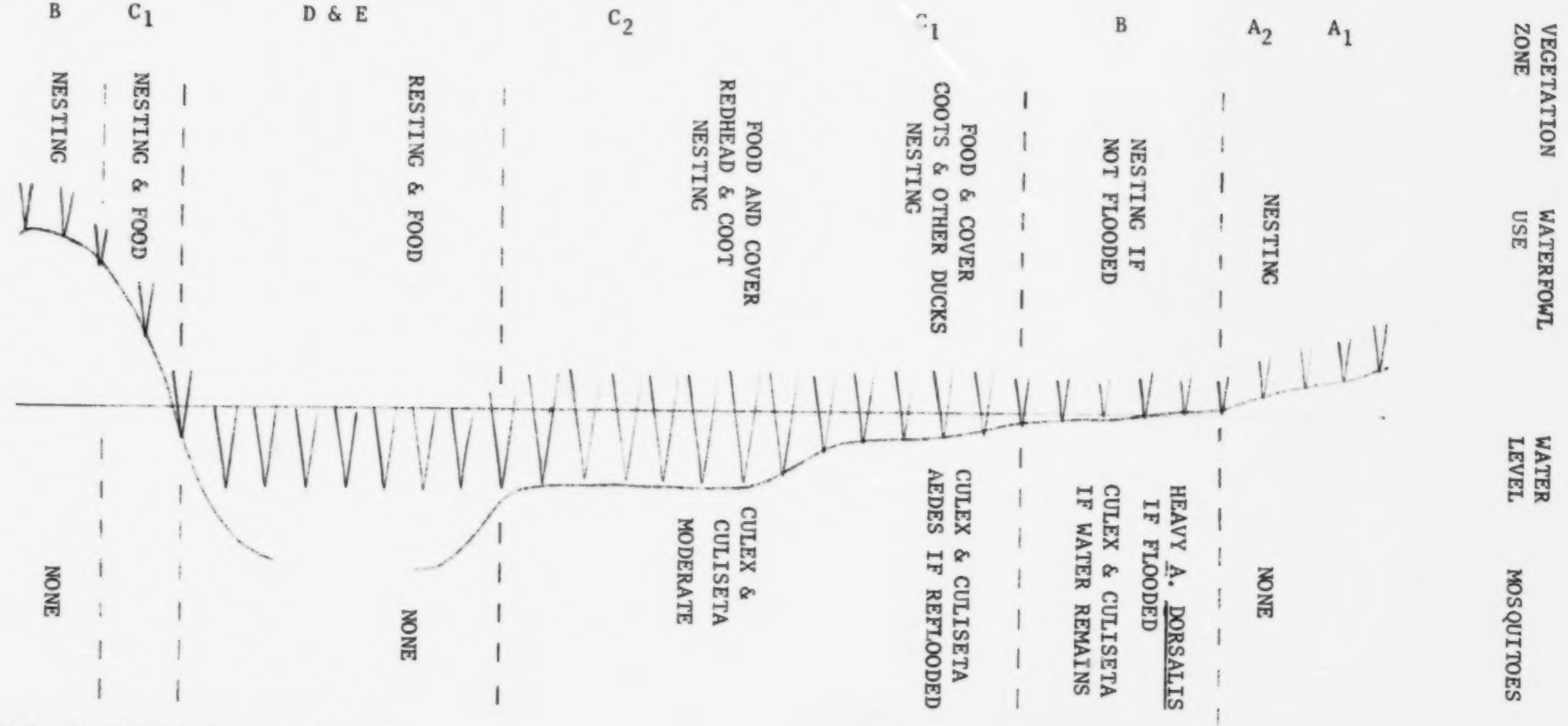
Mosquito production in the emergent marsh zone varies with the vegetation type and density, water depth and season of the year but is generally lower in productivity than in flooded salt grass. In general the denser the vegetation the higher the mosquito production. The mosquito production appears to be greatest at depths of 4 to 8 inches. The production decreases below and above these depths and no larvae were found in the study areas in depths above 12 inches.

The waterfowl nesting in emergent marsh zones was highest in areas where the vegetation was quite dense and the water was not more than 12 inches in depth. In the deeper areas the nesting was limited to coots and redhead ducks.

From the preceding information it seems that mosquito control and waterfowl management practices are incompatible in the emergent marsh areas since the waterfowl are favored by dense vegetation and shallow water the same conditions which favor mosquito production. However, the nesting season for waterfowl is in the spring and early summer while the peak mosquito season in this zone is in mid summer. The water in this zone can be managed for waterfowl during the nesting season and for mosquito control after the nesting season. The emergent marsh plants, especially alkali bulrush (S. paludosus), also produce large quantities of waterfowl food.

Appendix Figure 2

WATERFOWL MARSH PROFILE


VEGETATION ZONE
WATERFOWL USE
WATER LEVEL
MOSQUITOES
B
C1
D & E
C2
C1
B
A2
A1
NESTING
NESTING & FOOD
RESTING & FOOD
FOOD AND COVER REDHEAD & COOT NESTING
FOOD & COVER COOTS & OTHER DUCKS NESTING
NESTING IF NOT FLOODED
NESTING
NONE
NONE
CULEX & CULISETA MODERATE
CULEX & CULISETA AEDES IF REFLOODED
HEAVY A. DORSALIS IF FLOODED
CULEX & CULISETA IF WATER REMAINS
NONE

A_1 - Upland vegetation (greasewood)
A_2 - Upland vegetation (pickleweed)
B - Moist soil vegetation (salt grass)

C_1 - Shallow emergent vegetation - (alkali, Olney's, &
C_2 - Deep emergent vegetation - (hardstem bulrush, (cattails)

D - Submergent vegetation (chara, widgeon, grass, sago pondweed)

E - Floating aquatic vegetation (duckweed)

Figure 3. Lake Front Gun Club

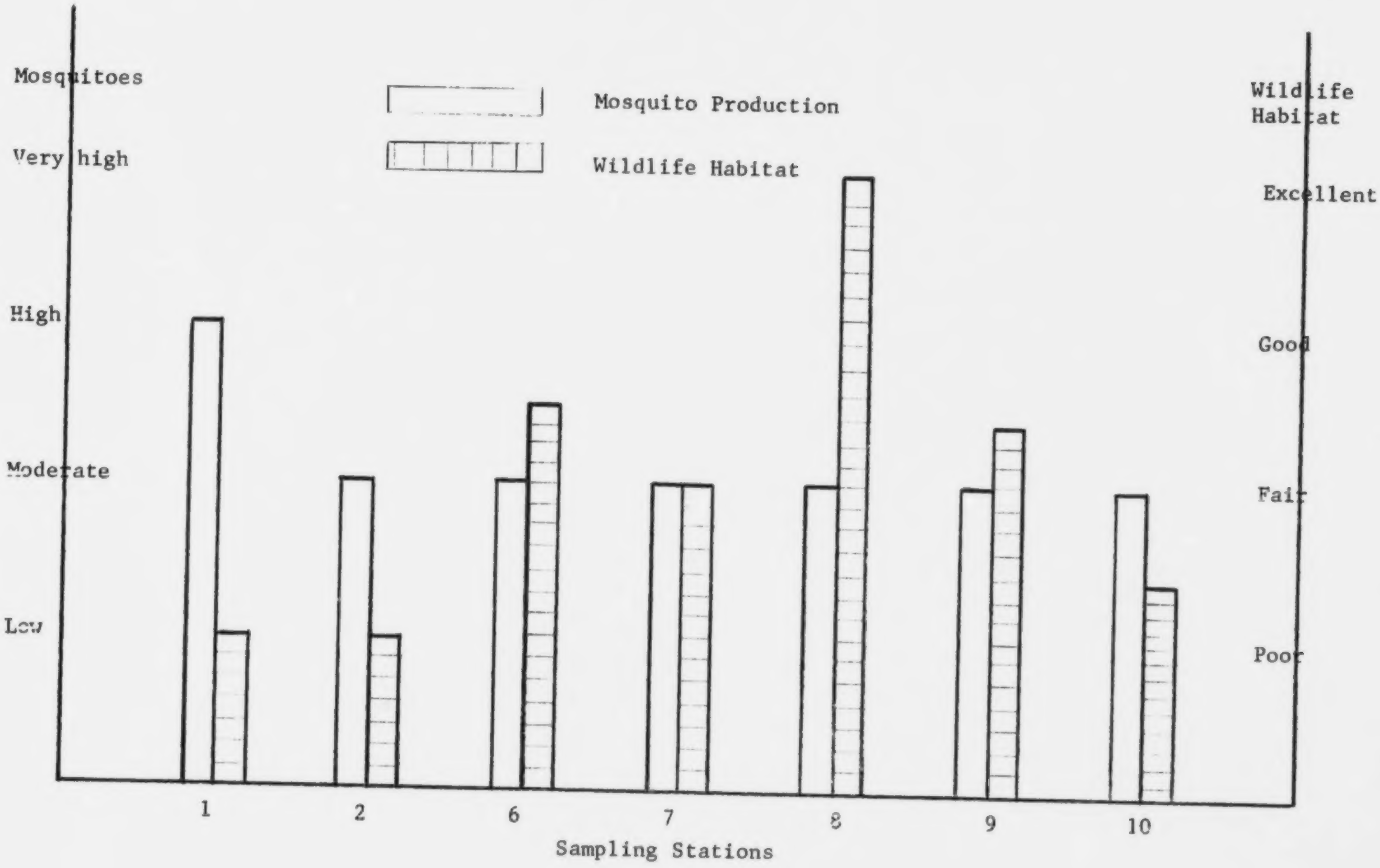
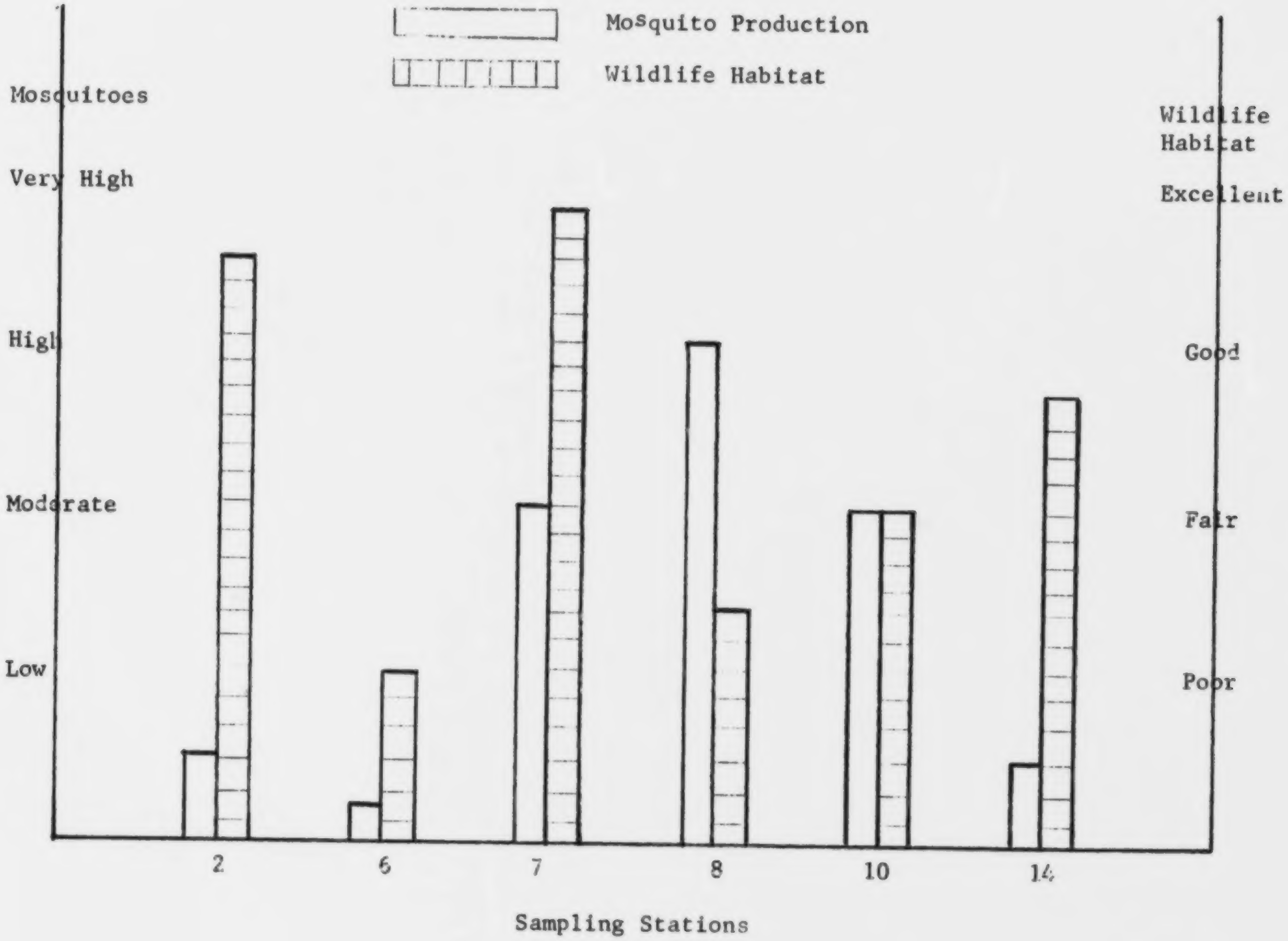


Figure 3. Farmington Bay Waterfowl Management Area



No mosquito production was found in the submergent vegetation zone. The submergent vegetation, consisting largely of chara, sago pond weed and widgeon grass, is excellent food for the waterfowl.

Some mosquito larvae were found in the floating aquatic vegetation when the mats were broken. When the vegetation formed a solid mass on the water surface, no larvae were found.

Figure 3 summarizes the relation between the sampling stations for mosquito production and for waterfowl habitats.

Table 17 indicates the vegetation types, the water management techniques used and the results in mosquito production and waterfowl habitat for each sampling station. A more detailed discussion of each station is presented in the Appendix, page

B. Water Management Program for Mosquito Control

All or any of the management practices listed in table 17 were successful in mosquito control under suitable conditions and proper application. The type of management used should depend upon the amount of water available, the size of the unit, the kind and amount of vegetation, the objective for the use of the unit, and the degree of mosquito control required.

Permanent withdrawal of water from an area entirely eliminated mosquito production. If the water is withdrawn from the entire marsh area it would obviously eliminate the waterfowl habitat. Therefore, permanent withdrawal was only applied on selected areas of moist soil vegetation (salt grass) during the mosquito season. This practice not only eliminated mosquito production in these areas but also created safe avian nesting sites in the moist soil vegetation.

Permanent flooding during the mosquito season eliminated the production of the flood water mosquitoes but in some instances provided a better aquatic habitat for the permanent water mosquitoes. In the permanently flooded areas no mosquito larvae were found in water depths of 12 inches or more. It was found that a 12-inch water depth is generally too deep for nesting for most waterfowl. A 12-inch water depth was difficult to maintain during the summer months when there was generally a decrease in the water supply and an increase in evaporation rate. This type of water management is possible when there is sufficient water the entire season to maintain a proper water depth and when a unit is designed for feeding and loafing activities of waterfowl rather than nesting.

Seasonal drawdown during the mosquito season was the most versatile management program for the prevailing condition of a plentiful water supply during the spring runoff in May and June, a steadily decreasing supply in July, August and early September, and an increase in late September and October as the agricultural irrigation season ends. The drawdown may be either rapid or gradual according to the local conditions and desired results. This drawdown should not begin until after the high water peak which is generally attained in June. A drawdown before this time may result in the reflooding of areas with subsequent production of broods of Aedes mosquitoes. Stabilizing the water levels until after the high water peak greatly reduced flood water mosquito production. After the middle of June C. inornata began to appear in increasingly greater numbers. These mosquitoes generally appeared first in the shallowly flooded moist soil (salt grass) vegetation. Rapid drawdown of the water from the salt grass areas helped to alleviate this mosquito production during this period. If the C. inornata did not constitute a mosquito problem, a gradual drawdown seemed to be a better management technique. Around the middle of July the C. tarsalis increased rapidly, appearing in greater numbers first in the salt grass areas, if they were flooded, and then in the bulrush and cattail areas. A gradual drawdown of the water first from the moist soil vegetation and later from the emergent marsh vegetation was partially, as high as 87%, effective in controlling C. tarsalis. This drawdown from the emergent marsh was applied after the waterfowl nesting season and apparently did not affect those birds which prefer to nest over the water. Periodic drying of certain parts of the marsh also had the effect of retarding ecological succession and maintaining marsh conditions. This drying was also useful or necessary in order to bring equipment into certain areas for construction of dikes or for mechanical removal or thinning of undesirable vegetation. The dried areas were again reflooded just prior to the hunting season in late September or early October. Any mosquitoes produced this late in the season were either destroyed by the cold weather or were restricted in their movement and thus did not constitute a problem except for inhabitants or visitors on the marsh. Seasonal drawdown with prevention of reflooding of dry areas also protected waterfowl nests from destruction by flooding. The submergent marsh areas should remain permanently flooded throughout the summer. In some instances it seemed to be advantageous to deepen part of these permanently flooded areas to provide less danger of the complete removal of the water from this part of the marsh in years of low water supply. In these deeper areas more water was stored with reduced surface area thereby reducing water loss by evaporation. On the Lake Front Gun Club deep barrow pits created by the removal of earth for dike construction served as deep ponds which, at times, was the only water remaining in an otherwise dry marsh.

Flood irrigation without water impoundment was used to introduce and stimulate growth of marsh vegetation onto previously barren soil. If the water supply was sufficient, alkali bulrush was generally the first plant to appear. This type of irrigation where the water was uniformly distributed and either penetrated the soil or continued to flow over a level surface did not create mosquito producing situations. If the water stagnated in small depressions mosquitoes at times found a suitable habitat. Mosquito production in these situations was noted especially when salt grass was present rather than bulrush. Successful waterfowl and shore bird nesting was very high in these areas when the water depth remained 2 inches or less. The birds generally used slightly elevated areas not covered with water for their nesting sites.

Water must be carefully controlled in these areas to prevent the flooding of the established nests.

The type of water management employed on any marsh unit must be flexible and adapted to the water supply, the objectives for its use and the water management structures available for its application in that particular situation or area. The management practices should also be dictated by the interests of all who are concerned with soil and water use in a given area.

C. Fluctuations in Water Surface Area

The extent of fluctuation in water surface area on the marshes is calculated on the actual gradient of approximately one foot per mile and one linear foot of shoreline on a retaining dike.

Figure 4 shows that there will be an increase or decrease of 528 square feet of water surface area, per foot of shoreline, for each one-tenth of a foot increase or decrease, respectively, in water depth.

Effects of Water Level Fluctuation in Marsh Areas

Figure 5 shows that for one thousand feet of shoreline each increase in water depth of one-tenth of one foot increases the water surface area by approximately twelve acres. The average seasonal fluctuation for nine stations on the Lake Front Gun Club was over eight-tenths of a foot druing 1962. As depicted in Figure 5 fluctuations of this magnitude could result in increasing the water surface area by as much as ninety-six acres per thousand feet of shoreline. This increase in the area flooded could result in the production of over four hundred million mosquito larvae when estimated on maximum larvae production for this area. The cost of control measures could exceed one hundred dollars per flooding, and numerous waterfowl nests would probably be destroyed if the flooding occurred during the nesting season.

D. Probable Effects of Shoreline Modification

In Figure 6 , Situation 1 shows the water extending into what can be termed a "problem zone" where the water is eight inches or less in depth extending into a salt grass area. This situation is conducive to extensive mosquito propagation. If water fluctuation occurs waterfowl nests may be destroyed also.

In Situation 2 the shoreline has been modified to eliminate the "problem zone" resulting in only minor mosquito production, practically no flooding of waterfowl nests and a thirty-three percent reduction in evaporation rate is attained. It should be noted that the rate of evaporation at the Farmington Bay Waterfowl Management Area was almost seven inches during the month of July, 1964; therefore, water loss due to evaporation is a significant consideration in the marsh areas.

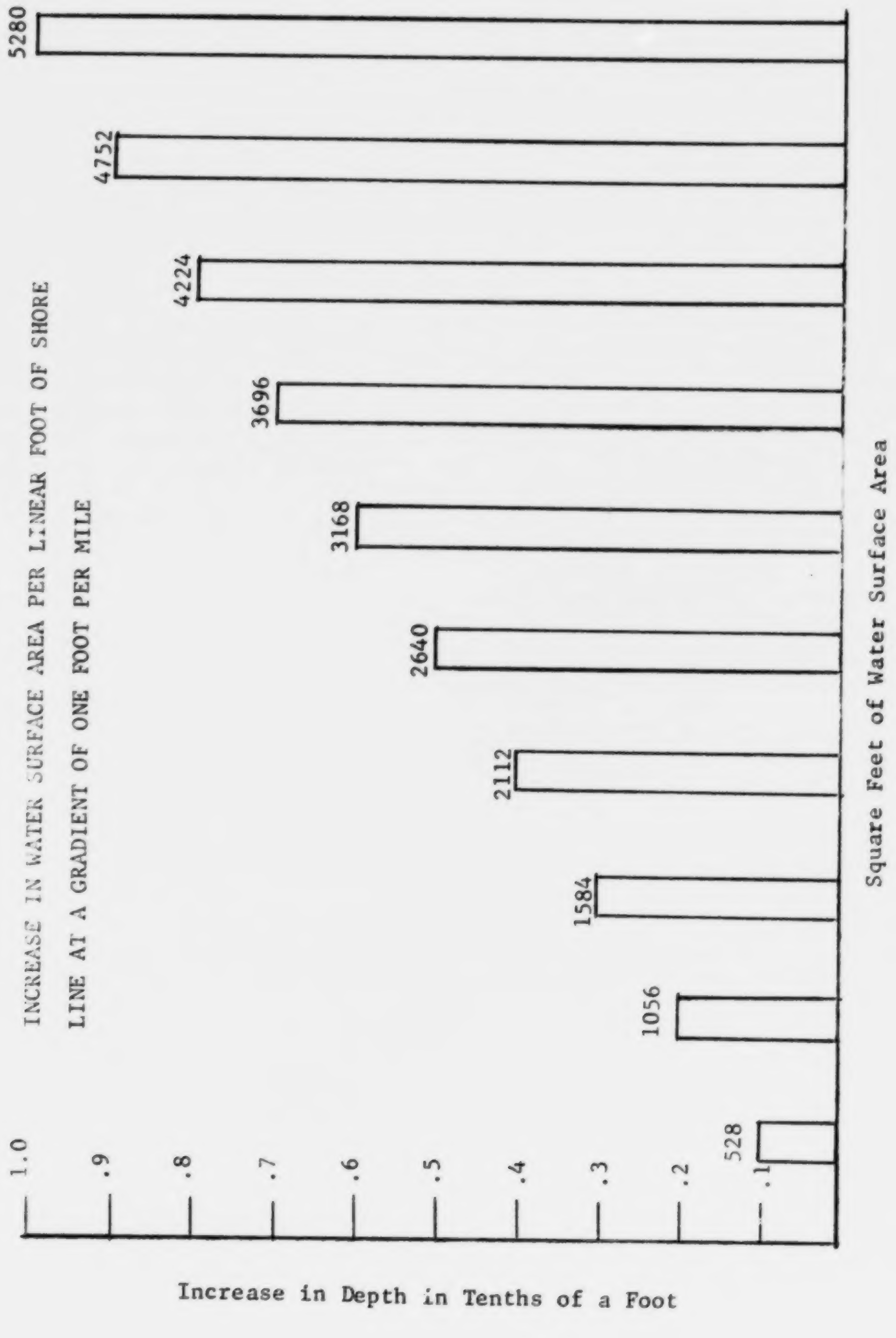
According to studies at Howard's Slough, conducted as a cooperative program at Utah State University, evapotranspiration is approximately 44 inches per year with a peak of nine inches in July. It was also determined that 40-90 inches of water per year, in addition to normal precipitation, is necessary to maintain the proper salt balance for marsh vegetation. The lower the water quality the more water is needed. Howard's Slough is in the proximity of the three study areas.

E. Comparison of Mosquito Production on Managed and Unmanaged Areas

Figure 7 compares the number of acres treated with larvicides by aircraft on the Lake Front Gun Club where water management practices are conducted, with a similar unmanaged area where mosquito abatement was not considered. The water on the unmanaged area was retained at a low level during most of the summer but each fluctuation in the amount of water entering the area resulted in extensive flooding. The water on the Lake Front Club was stabilized. The production of *A. dorsalis* on the unmanaged area was over three times that on the Lake Front Club where the water was stabilized at a more constant level.

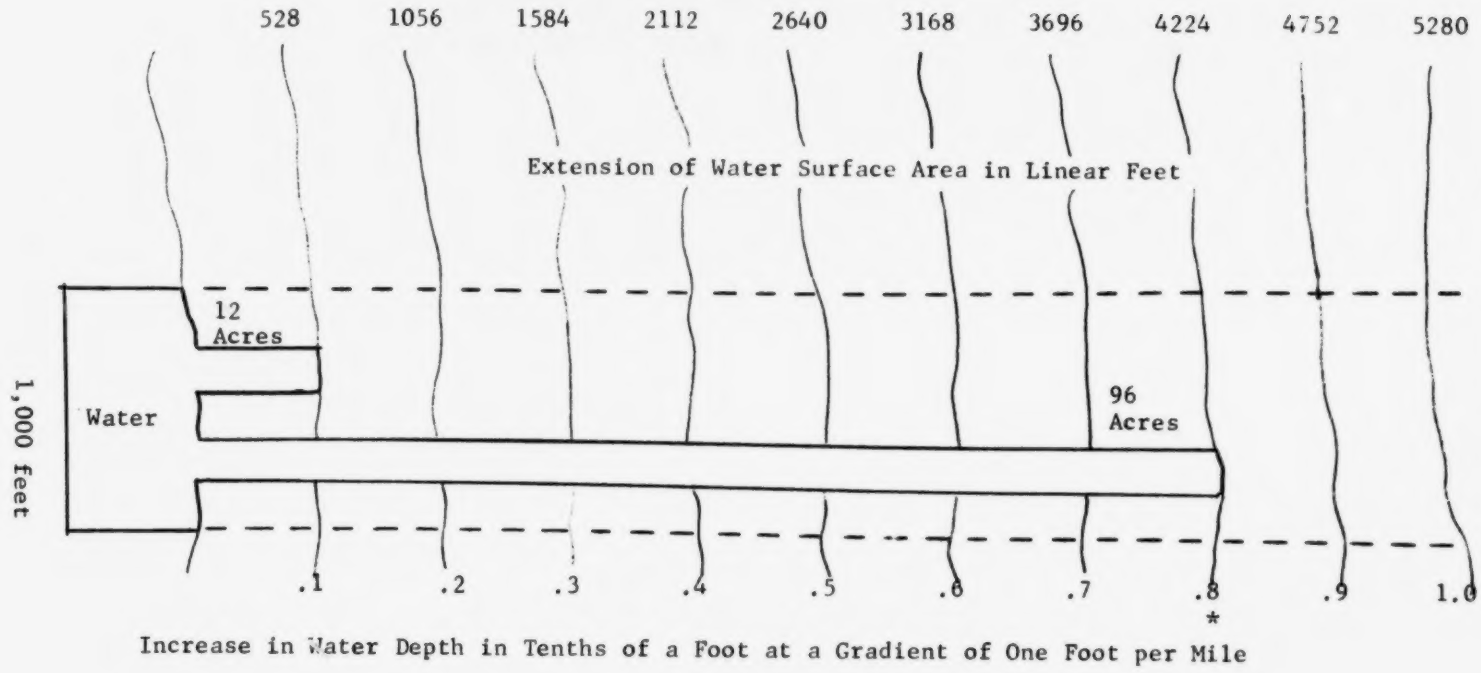
Water management resulted in a 24% reduction in the total acres treated on the Lake Front Club. This difference is actually of greater significance as the Lake Front Club is much greater in area than the unmanaged club used for comparison.

Figure 4.



INCREASE IN WATER SURFACE AREA PER LINEAR FOOT OF SHORE LINE AT A GRADIENT OF ONE FOOT PER MILE

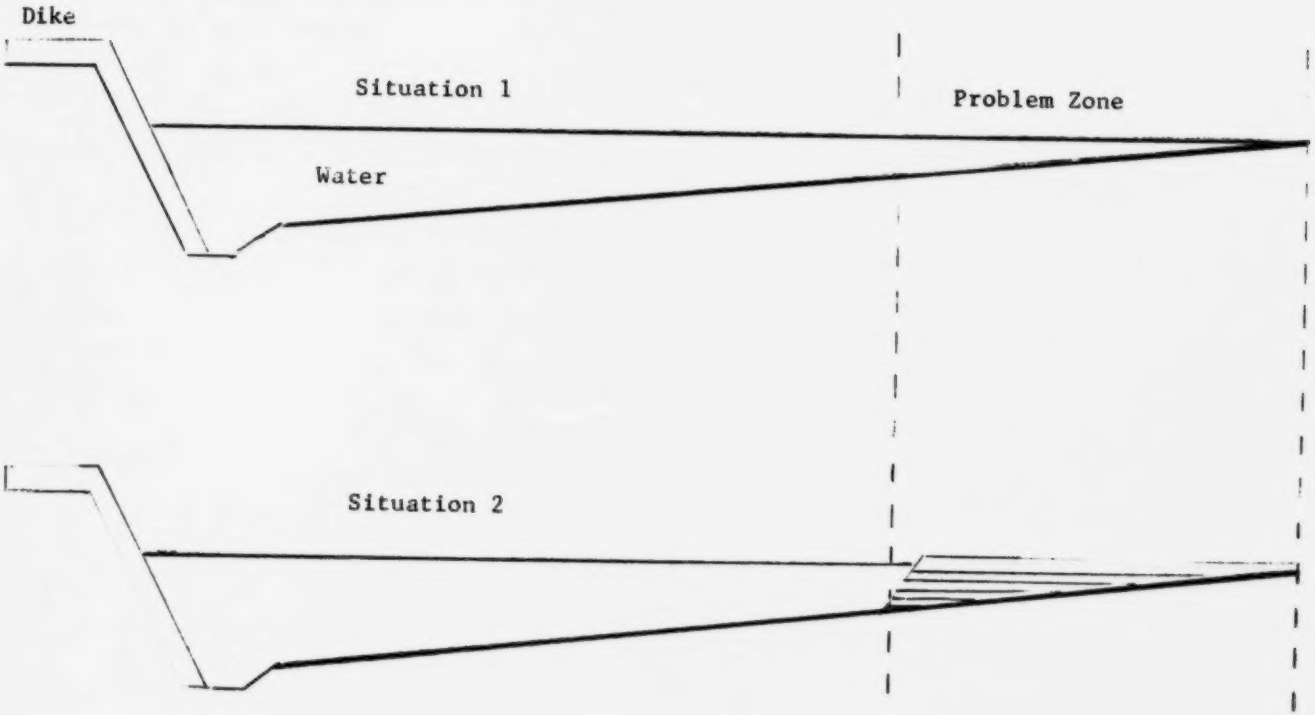
Figure 5. EFFECTS OF WATER LEVEL FLUCTUATION IN MARSH AREAS


528
1056
1584
2112
2640
3168
3696
4224
4752
5280
Extension of Water Surface Area in Linear Feet
12 Acres
Water
1,000 feet
96 Acres
.1
.2
.3
.4
.5
.6
.7
.8
*
.9
1.0
Increase in Water Depth in Tenths of a Foot at a Gradient of One Foot per Mile

* Average Seasonal Fluctuation on Nine Larval Sampling Stations on the Lake Front Gun Club in 1962

- In terms of water surface area	96 acres increase
- In terms of mosquito larvae produced	418,176,000
- In terms of dollars for mosquito control	$100.00 per flooding
- In terms of waterfowl nests destroyed	??????

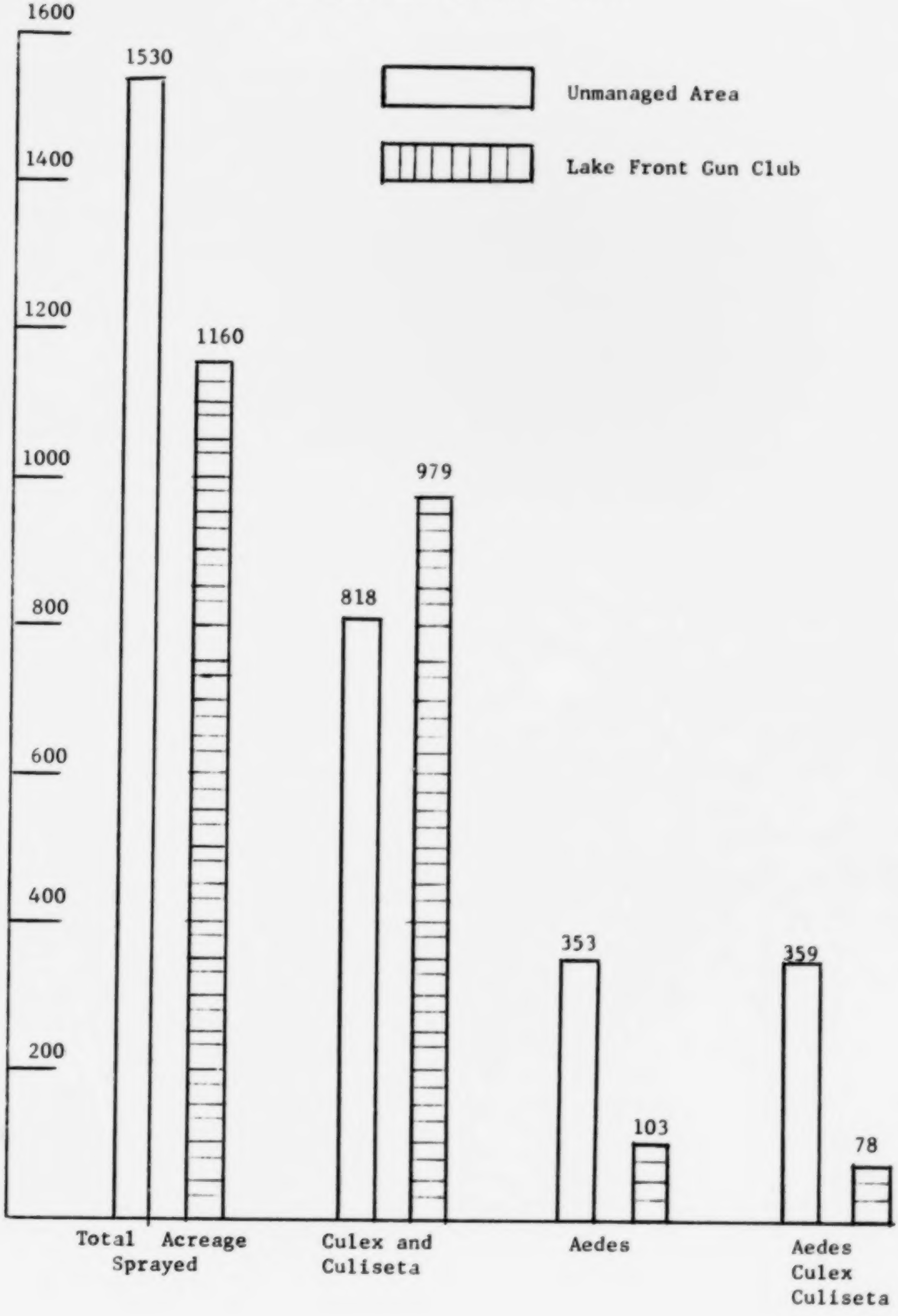
Figure 6. PROBABLE EFFECTS OF SHORELINE MODIFICATION


Dike
Situation 1
Problem Zone
Water
Situation 2

- Greatly reduces mosquito problem area
- Greatly reduces flooding of waterfowl nests
- Greatly reduces water loss due to evaporation

Figure 7.

COMPARISON OF AERIAL TREATMENT
ON MANAGED AND UNMANAGED AREAS



V. SUMMARY

A. Introduction

The following is a summary of the results, conclusions, and recommendations obtained from a cooperative water management study conducted from September, 1961, to August, 1965, on three selected study areas located on the eastern shores of the Great Salt Lake. The conclusions and recommendations should be applicable to other areas where similar conditions exist.

This section of this report was discussed, modified and approved on January 14, 1966, by representatives of collaborating agencies and other collaborators participating in this study.

B. Results

It was determined that the water on the study areas is being used for the development and maintenance of marshlands and for irrigation of agricultural crops.

1. The marshlands provide:
    - a. a habitat for about 140 species of birds, 29 species of mammals, 7 species of fish and numerous reptiles, amphibians and invertebrate animals;
    - b. recreation for man in the form of hunting, fishing, boating, picnicking, photography and nature studies;
    - c. commercial crops such as carp, muskrat pelts, forage for domestic animals, salt grass as a packing material and bedding for livestock and on private property the lease of hunting privileges.
2. Agricultural crops produced on some of the higher ground adjacent to the marsh land provide:
    - a. grazing for domestic animals on native and improved pastures;
    - b. salt grass for packing material and bedding for livestock;
    - c. forage and grain crops such as clover, alfalfa and barley;
    - d. food and cover for wildlife.
3. Some existing water management structures, techniques and practices used on the study areas, particularly on the marsh land, native pastures and salt grass crops, contribute towards the production of considerable numbers of pest and disease-vector insects such as:
    - a. six species of mosquitoes, two of which are produced only on ground recently flooded, the other four species are produced in more permanent water;
    - b. two prevalent species of biting deerflies and one horsefly which develop in water and emerge from moist soil;
    - c. one biting and several species of nonbiting gnats that develop in water and/or moist soil;
    - d. and of lesser importance, numerous species of noxious insects and other Arthropods.

C. Conclusions

1. Limitations of multipurpose use of water to provide the greatest mutual benefits to fish and wildlife, recreation, agriculture, public health and related programs:
    - a. The present quality of the soil and water in the marsh land restricts the use of this land and water to its continuance as a marsh; however, there is a need and a great potential for improving conditions in certain areas in the marsh in order to provide greater beneficial use for all programs concerned. Further deterioration of the water quality could prevent its use for agricultural and wildlife development and increase its potential as a health hazard.
    - b. The quality of the soil on some of the ground at higher elevations and some of the water of better quality make it possible to produce pasture and satisfactory yields of selected agricultural forage and grain crops; however, at present the expense involved in preparing the land and acquiring and applying the water for agricultural crops makes the cost involved prohibitive for most land owners.
2. Effects of water management practices on mosquito production and waterfowl habitat on the study areas.
    - a. Impoundment of water to flood a marsh almost invariably creates mosquito producing situations that may also detract from the marsh as a waterfowl and wildlife habitat unless adequate water control structures are installed and suitable water management techniques and practices are applied.
    - b. Water management practices applied and conclusions derived:
        - (1) Permanent withdrawal of waters from moist soil vegetation (salt grass complex) eliminated mosquito production and created safe sites for upland nesting waterfowl.
        - (2) Permanent flooding during the mosquito season eliminated the production of Aedes, the flood water mosquitoes, but provided more permanent water required for the production of Culex and Culiseta mosquitoes. Stabilizing the water at 12 inches or more in depth virtually eliminated all types of mosquito production at this depth. Stabilizing the water level also prevented the flooding of established waterfowl nests and influenced the change in vegetation from a moist soil to a more desirable emergent or submergent type.
        - (3) Seasonal drawdown during the mosquito season was the most versatile management practice for the existing water conditions and was successful in reducing both floodwater and permanent water mosquitoes. The drawdown may be either rapid or gradual but dry areas should not be reflooded before the end of the mosquito season. Seasonal

withdrawal protects waterfowl nests from destruction by flooding. Periodic drying of certain types often has the effect of retarding or setting back ecological succession and may be effective in maintaining a given section of marsh in a desirable successional stage.

(4) Flood irrigation where the water was uniformly distributed and either penetrated the soil or continued to flow over a level surface did not create mosquito-producing situations. Such irrigation is useful in introducing marsh vegetation into previously barren soil. Successful nesting in these areas was very high when water depth remained 2 inches or less.

(5) Water management techniques and practices used in this study that were effective in mosquito abatement often improved the marshes for waterfowl and other wildlife.

(6) Areas where water management for mosquito control was not practiced were in general highly productive of mosquitoes and other noxious insects and were of lesser value as wildlife habitats.

c. The development and improvement of multipurpose water management programs on the marshes and adjacent agricultural ground can be accomplished for the mutual benefit of all concerned without a significant curtailment of the objectives of any of the current programs.

d. On parts of the three study areas used in this investigation these multipurpose water management methods and techniques are demonstrable and can be used for this purpose.

3. As a result of this study the participants and others have become more fully aware and conscious of the objectives and requirements for multipurpose use of the water and the mutual benefits to be derived from such a program.

D. Recommendations

1. The development and improvement of multipurpose water management programs on these marshes and adjacent agricultural ground can be accomplished by:
   a. determining the objectives of the water use and the definite boundaries of the areas upon which it will be used;
   b. determining the probable maximum and minimum flow of water available for each area and, as soon as possible, establish legal ownership and thus responsibility for its use;
   c. providing a by-pass for excess water during maximum flow;
   d. providing adequate structures for introducing, confining and removing the water and managing it on the selected area to obtain the desired objectives while it is in use and for its proper disposal after use.

2. Water Management Structures
    a. Use dikes to divide the marsh into units in which the water can be maintained and the level stabilized when the unit is in use.
    b. The units should be small enough to be maintained during periods of minimum water flow and sufficient in number for extending the water in the marsh when water is available and there is a need for additional flooded areas. As a guide in this planning the Utah State Department of Fish and Game calculate that each cubic foot per second flow of water entering a marsh can irrigate or flood one hundred acres of marsh ground.
    c. Dikes should be constructed where necessary to confine the water on all sides within each unit.
    d. Dikes should have a roadway adequate for automobile travel.
    f. Inlets and outlets and channels leading to and from each unit should be adequate in size to accommodate the maximum flow entering each unit.
    g. Spillways must be adequate in width and/or number to provide for the rapid outflow of any potential increase in the amount of water entering a unit. A guide has been prepared that can be used in designing adequate spillways for this purpose (see Appendix Page 53).
    h. The design, specifications and installation of the recommended units should be made in accordance with approved engineering principles and practices.

REVIEW OF LITERATURE

Rees and Chamberlin (1930), referring to the production of broods of Aedes dorsalis (Meign) on marshes bordering the Great Salt Lake, maintained that these mosquitoes could be greatly reduced in numbers by proper care of the water on these marshes. Kay (1956), referring to this same area, stated that fluctuating water levels on the marshlands is generally considered a curse to bird life.

Rees (1939) cited the origin of mosquito producing waters in the vicinity of Salt Lake City, Utah. One of the sources discussed was water impounded for waterfowl. He stated that these impoundments formed by levees and dikes constructed at the mouth of the Jordan River and Surplus Canal are shallow and more or less of a temporary nature. Under certain conditions, large broods of mosquitoes develop in these impoundments.

The Federal Security Agency, U.S. Public Health Service, and Tennessee Valley Authority Health and Safety Department (1947) made an extensive study on malarial control on impounded water. In this study under anti-larval measures is a recommendation for the alteration of the breeding habitat which included water level management. This proposed management consists of five phases: 1) initial filling, 2) surcharge, 3) constant level pool, 4) cyclical fluctuation, and 5) seasonal recession. This report states, "One of the most important objectives in water level management for mosquito control is the manipulation of the water level so as to eliminate or minimize the intersection line (intersection of the water surface by vegetation and flotage) in mosquito breeding areas...at the proper time and intervals." Important accessory measures along with water level management are proper reservoir preparation and shoreline maintenance.

The U.S. Department of Agriculture (1954) Handbook No. 60 discusses in detail the determination of the properties of saline and alkali soils and the improvement and management of these soils. It discusses water quality analysis and the classification of irrigation waters. Found in this publication are plant responses to saline and alkali soils and crop selection for these soils.

Nelson (1954) reported on the development and restoration of waterfowl habitats at Ogden Bay Refuge (Utah). In this report he traced the history of the development of this refuge and the ecological changes that took place in diked and irrigated areas. These ecological changes include both the vegetation and wildlife. Nelson (1955) made a study of the ecology of the Great Salt Lake marshes and discussed both the dry land and aquatic vegetation. He discussed the ecological relationships of the waterfowl to the marsh habitat.

Wolf (1955) discussed some effects of fluctuating and falling water levels on waterfowl production. He reported that flooding caused a loss of 31% of potential waterfowl production on the Cutler Reservoir (Utah). This reservoir is characterized by fluctuating water levels.

Rees (1956), reporting on the problem of mosquito production on the waterfowl marshes in Utah near the Great Salt Lake, described practices of impounding water which have resulted in mosquito production. He made proposals to improve existing conditions which included maintaining constant water levels, cooperation of property owners, and further studies of the marshes by qualified persons. Rees (1961) stated, "The problem of mosquito abatement is basically one of proper water management directed at preventing the creation of suitable water habitats in which mosquitoes can be produced."

McHugh, *et al.* (1957 unpublished manuscript) reported on the interrelationships of plants, mosquitoes, and waterfowl in the Great Salt Lake Area. He presented an overall evaluation of the mosquito breeding potential and the waterfowl values of ten basic plant types which were studied. Among other management procedures for mosquito control, McHugh recommended: 1) Avoid flooding of flexuous and upland types of vegetation during the growing season to prevent mosquito production and destruction of waterfowl nests, 2) minimize shallow water areas and increase the extent of deep water areas adjoining marginal and upland plant types, and 3) develop more open water stands of floating leaf and submergent aquatics in order to increase waterfowl food and minimize mosquito-breeding potential.

Springer (1958) suggested the following points to integrate the interests of mosquito control and wildlife in North Carolina: 1) Mosquito control and wildlife programs should be undertaken only where they are clearly in the public interest. 2) In either type of program, detailed plans should be made giving adequate attention to entomological, biological, engineering, and toxicological aspects and taking into account the individual character of each marsh. 3) Prior to its initiation, the program should be discusssed with interested wildlife or mosquito control groups. 4) Provision should be made for adequate maintenance of projects. 5) If conflict arises between groups involved in a program, joint studies should be made to resolve the differences.

In April, 1959, a symposium for Coordination of Mosquito Control and Wildlife Management (1960) sponsored by the American Mosquito Control Association, U.S. Bureau of Sport Fisheries and Wildlife, Wildlife Society, U.S. Department of Agriculture, and the U.S. Public Health Service was held in Washington, D.C. The proceedings of this symposium were published in 1960. The general headings of this publication are: 1) Fundamentals of Mosquito Biology and Control; 2) Fundamentals of Wetland Wildlife and Fish Management; 3) Methods of Chemical Mosquito Control and Effects of Fish and Wildlife; 4) Water Management for Mosquito Control and Wildlife Management. Several papers were presented under each of these headings by persons representing both mosquito control and wildlife interests.

Kadlec (1962) reported on the effects of a draw-down on a waterfowl impoundment in Michigan. Included were the effects on vegetation, waterfowl, soil, water, and bottom fauna. He stated that draw-down is a natural and effective method of maintaining the productivity of a waterfowl marsh and that many of the most productive waterfowl areas are subject to natural "draw-down" as a result of droughts. Soil and water analyses indicated a definite increase in plant nutrients. The plant species composition was not notably affected but there was an increased abundance and an increase in spread of most emergent species. Invertebrate populations were considerably reduced by the draw-down but waterfowl utilization of the area increased. The effects of the draw-down were placed into three categories. First, a temporary abundance in the form of seeds of wetland plants. Second, it provides suitable conditions for the establishment of emergent cover. Third, it may result in soil improvement and in improved aquatic plant food production upon flooding.

In October, 1962, a conference for coordinated program on wildlife management and mosquito suppression was held at Yosemite National Park, California. The proceedings, including both submitted papers and transcriptions of tape recordings, have been mimieographed and distributed but do not constitute a publication. Papers given at this conference emphasized the need for cooperative efforts between persons and agencies involved in wildlife management and mosquito supression. Discussions at concurrent group sessions brought out the potential wildlife management and mosquito suppression practices from physical, chemical, and biological aspects.

The activities of the National Mosquito Control-Fish and Wildlife Management Coordination Committee have been reported for three years (Springer and Vannote, 1961; National Committee, 1962; and Quarterman, 1963). This committee arose as an outgrowth of the Symposium on the Coordination of Mosquito Control and Wildlife Management held in Washington D.C., in 1959. The objective of this committee and the efforts to realize these objectives have been outlined in these reports.

Springer (1964) discussed ways of satisfying environmental needs of desired wildlife species while encouraging conditions unfavorable for mosquitoes. He discussed physical principles such as impounding, temporary flooding, controlled ditching, and sump drainage. Under biological principles he discussed animal and plant relationships. He emphasized that mosquito control and wildlife management should be compatible and coordinated and should be based on a knowledge of the biology of the species involved and on the ecological factors causing population increase or decrease.

Rees, *et al.*, (1963b, 1964, 1965) prepared annual reports on the development of techniques for multipurpose management of reusable water before it enters the Great Salt Lake. These reports included records on mosquito and wildlife production and factors affecting this production in three study areas on the eastern shores of the Great Salt Lake, Utah. They also included results of qualitative and quantitative water sampling, soils and soil capabilities, weather, and encephalitis surveillance studies. Recommendations for improved water management practices beneficial to public health, agriculture, fish and wildlife, and other interests were made. These reports covered the first three years of a four year study. Reports on different parts of this study were made by Rees (1962, 1963); Andersen and Rees (1963, 1965); Andersen, Rees, and Arnold (1964); and Arnold (1963).

MATERIALS AND METHODS

A. Duration:

This study was initiated on September 1, 1961, and continued to August 31, 1965. Field data were gathered primarily from April 1 to September 30th with some field studies continuing throughout the year.

B. Soil:

Soil surveys of the Lake Front Club and the Wheeler Test Area were made respectively by the Salt Lake County and Davis County Districts of the Soil Conservation Service. The soil was classified, usability and limitations determined, and soils maps prepared by this collaborating agency.

C. Water:

Salinity. Weekly water samples were taken from nine selected stations in the study areas from April to September during 1963 and 1964. The salinity was determined by analysis with a solu-bridge conductivity meter and measured in specific conductance in micromhos per centimeter at 25 degrees centigrade.

Alkalinity: Alkalinity was measured in terms of sodium absorption ratios calculated from ion analysis data obtained from water samples analyzed by the U.S. Geological Survey and the Soil Conservation Service.

Ion Analysis. Water samples were collected from selected sampling sites in May, July, and September of 1963 and 1964 and submitted to the Soil Conservation Service Water and Soils Laboratory for complete ion analysis. Data were also obtained from the Water Quality Branch of the U.S. Geological Survey from water samples taken in streams discharging into the study areas.

Biochemical Oxygen Demand (BOD). During 1963 and 1964 water samples were taken each month from four selected sites in the study areas and submitted to the Utah State Health Department for BOD determination based on 5-day BOD at 20° centigrade measured in parts per million oxygen.

Most Probable Number (MPN) Coliforms. Bacterial analysis measured in MPN coliforms was made by submitting monthly samples of water from four selected sampling sites to the laboratory of the Utah State Department of Health. Samples were taken from April to September 1963 and 1964.

Additional information on BOD and MPN of sewage effluent entering into the study areas was obtained from records of the Utah State Department of Health and from records maintained at the sewage treatment plants.

From the above analyses the water was classified from a public health and an agricultural aspect. The bases for these classifications are presented on page 145.

Water Quantity. In 1963 six water quantity continuous flow recording gauging stations were established in Salt Lake County by the Geological Survey on the principal streams supplying water to the study areas. The stations were located at: 1) the Jordan River at 21st South, 2) the Jordan River at Cudahy Lane, 3) the Surplus Canal at 21st South, 4) the Surplus Canal at Cohn's Slough, 5) the Goggin Drain and 6) the North Point Canal at Highway 40. Daily water flows measured in cubic feet per second were obtained from these gauges. In addition, discharge rates from sewage treatment plants and pumping stations were obtained from sewage districts and estimates of stream flows from other streams entering the study areas were obtained from the Surface Water Branch of the U.S. Geological Survey.

Fluctuations in water depth were determined by placing staff gauges in selected locations. Readings of these gauges were made at least once each week or more frequently if workers were in the vicinity of the gauges. These gauges were read in tenths of a foot increments. Fluctuation in surface area covered by the water resulting from the fluctuation in water depth was determined by measuring in linear feet the change in the extent of the water surface as the water rose or receded.

D. Mosquito Studies:

Larval Sampling. Sampling stations were selected on a basis of different types of ecological situations such as different plant associations and the different water conditions found in the three study areas. Initially 14 sampling stations were selected on the Lake Front Club, 16 on Farmington Bay, and 17 on the Wheeler property. To avoid duplication in effort, the number of stations was reduced in subsequent years to 7 on the Lake Front Club, 6 on Farmington Bay, and 16 on the Wheeler property.

Each station was sampled weekly from the first of April to the last of September from 1962 to 1965 inclusive. Samples were taken with a one-pint white enamel dipper along a predetermined transect. One dip was taken approximately every five paces as the sampler moved through the sampling stations. The total number of dips and the total number of larvae collected were counted and representative samples of the larvae were preserved for identification. Comparisons of mosquito production in different ecological situations were made on the basis of average number of larvae per dip calculated by dividing the number of larvae by the number of dips taken. Comparisons of mosquito production in the same sampling stations for different years and for different times of the same year was made on the basis of a mosquito production index calculated by taking the average number of larvae per dip times the size of the breeding area measured in acres. The latter method was adapted from that used by the Public Health Service (Smith 1962). This method of comparing mosquito production was used because of the fluctuating water supply which resulted in seasonal and yearly variation in the size of the area represented by the sampling stations.

During 1965 weekly larvae samples were taken from selected vegetative types on two areas of the Lake Front Gun Club. A comparative study of mosquito production in these vegetative types was made from the average number of larvae per dip.

Adult Mosquito Sampling. Adult mosquito populations were sampled by means of light traps, bite counts, and a car-top trap.

New Jersey type light traps were operated at the Davis County Mosquito Abatement Field Office at Kaysville, the manager's residence at the Farmington Bay Waterfowl Management Area, and at the North Treatment Plant of the South Davis County Sewage Improvement District. All traps were operated each week on Monday and Thursday nights from May to September during the four years of the study except the trap at Kaysville which was not operated in 1965. Light trap catches were identified and summarized as average weekly light trap collections. The average was obtained by dividing the total number of mosquitoes collected per week by the total number of collections made per week.

Bite counts were taken each week on Monday and Thursday nights from July to the end of September during the four years of the study. These counts were taken on the Lake Front Club, Farmington Bay, and the sewage treatment plant during 1963 and 1964 and only at Farmington Bay during 1965. The biting counts were taken for a period of thirty minutes beginning fifteen minutes after sundown. If the numbers of biting mosquitoes were exceptionally numerous, the collection period was reduced to fifteen minutes. The person taking the count exposed both legs to above the knees and collected the mosquitoes by means of an aspirator as they landed on the exposed skin. The mosquitoes were counted and identified and summarized as average number of mosquitoes collected per week.

In 1965 a car-top mosquito collecting trap was constructed from specifications obtained from the Bureau of Entomology, Florida State Board of Health. This trap was operated once each week on the Lake Front Club and the Farmington Bay areas from July to September. The collections were made for three consecutive fifteen-minute intervals commencing at sundown.

E. Wildlife Studies:

Vegetation. Qualitative and quantitative vegetation surveys were made in 1963 and 1965 on each of the larval sampling stations on the three study areas.

A list of plants in the study area was made using Nelscn's (Nelson 1954) list of marsh plants of the Ogden Bay Area as a check list supplemented by collections made during the study period.

Quantitative surveys were made by employing the generally accepted line point method. In this method a 100-foot steel tape is laid along a determined transect through the study area. The point, a 36-inch long brass welding rod, was dropped at one to four foot intervals, depending upon the uniformity of the vegetation, and the species of vegetation touching the point were recorded as "hits." The following formulae were used in analyzing the data:

$$\text{percent total cover} = \frac{\text{number of vegetative hits}}{\text{total number of points}}$$

$$\text{percent frequency of species A} = \frac{\text{hits of species A}}{\text{total number of points}}$$

$$\begin{array}{c}\text{percent relative importance}\\ \text{of species A}\end{array} = \frac{\text{hits of species A}}{\text{total number of vegetative hits}}$$

Birds. A list of birds observed at Ogden Bay Refuge 1940 to 1954 (Nelson 1954) was used as a basis to determine the waterfowl and other birds found in the study areas. This list was modified as a result of observations made by the investigators and by ornithologists at the University of Utah.

Each larval sampling station was rated on its value as a habitat for waterfowl by two personnel of the Utah State Department of Fish and Game who are experienced in waterfowl management and ecology. The stations were rated as excellent, good, fair, or poor on the basis of food, nesting sites and cover. This rating was originally made in 1962 and repeated by the same individuals in 1965.

Quantitative waterfowl surveys including migrating birds, nests, broods, and general utilization of the areas by waterfowl was made in 1965.

Mammals. A list of mammals was obtained by observations and collections of the investigators and through the personnel and records at the University of Utah. Additional information on muskrat houses in the larval sampling stations and from records of pelts taken from the sites by trappers.

Fish. A list of fish was obtained by seining selected sites in the study areas and identifying the fish that were collected.

F. Water Management Practices:

1. Structures:

To conduct a water management program, use has been made of the existing system of dikes, channels, reservoirs, weirs, and other water control structures present on the study areas. In addition 4,200 feet of dike were reconstructed with a dragline, 4,000 feet of dike were reinforced with a D-4 caterpillar, and 1,800 feet of new dike was constructed on the Lake Front Gun Club. Three new water control weirs were also constructed. Approximately 200 acres of agriculture land were leveled, graded, and planted or prepared for planting on the Wheeler Machinery Test Area. Also four water storage reservoirs and several miles of ditches and canals were constructed.

2. Techniques:

Permanent withdrawal. This consists of removing the water entirely from an area during the mosquito season. This management technique was used on part of Station 3 on the Lake Front Gun Club and Station 16 on the Wheeler Area.

Permanent flooding. This consists of flooding an area and keeping it covered with water during the entire mosquito season. This management technique was applied on sampling station 14 on Farmington Bay, stations 9 and 10 of the Lake Front Club, and stations 5, 8, 13, and 14 of the Wheeler Test Area.

Seasonal drawdown. This consists of flooding early in the season with a drawdown of the water level or complete removal of the water during part of the mosquito season and reflooding after the mosquito season. This technique can vary with the seasonal variation in the water supply and with the need for mosquito control. Two general types of seasonal drawdown were used in this study: 1) A rapid drawdown in which the water was rapidly removed from the emergent vegetation as soon as the high water from the spring run off was complete and 2) a gradual drawdown in which the water level was continuously lowered over a longer period of time corresponding to the normal decrease in water supply as the summer progressed. In both types of seasonal drawdown an attempt was made to keep the water from reflooding the dewatered areas until after the middle of September.

The rapid drawdown was used on sampling station 1, Lake Front Club and station 8, Farmington Bay. The gradual drawdown technique was used on stations 2, 6, 7, and 8, Lake Front Club; stations 2, 6, and 10 Farmington Bay; and stations 9 and 10 on the Wheeler Test Area.

Flood irrigation. This consists of flooding an area in which there are no structures to impound the water. Flood irrigation is commonly used in places where a new marsh is being developed. This type of water management may consist of maintaining a constant flow of water through an area or of periodic flooding. The type used generally varies with the availability of water. Sampling station 7 on Farmington Bay was managed through flood irrigation.

Sampling stations 1, 2A, 3, and 2B on the Wheeler Area are located in areas that are being modified for agricultural use and no additional water management was attempted at these stations; however, changes in mosquito production corresponding to the land development were observed.

Stations 4, 5, 6, and 10 on the Wheeler property are located in reservoir or pond areas and the effect of type of shoreline and water fluctuation on mosquito production was determined.

G. Agricultural Program:

A program of leveling, draining, and planting has been conducted on the Wheeler Machinery Company Test Area according to the plan prepared by the Soil Conservation Service.

H. Other Projects:

Climate. A class "A" evaporation station was installed at the Farmington Bay Waterfowl Management Area in September, 1963, by the U.S. Weather Bureau in cooperation with the Utah State Department of Fish and Game and the Salt Lake City Mosquito Abatement District as collaborators in this study. This station provides data on maximum and minimum daily temperatures, daily precipitation, pan evaporation, wind movement, and humidity.

Additional climatological data on temperature and precipitation was obtained from the records of the U.S. Weather Bureau at the Salt Lake City Municipal Airport.

Encephalitis Surveillance. Two sentinel chicken flocks of thirty birds each were established in the study area by the Disease Ecology Section, CDC, U.S. Public Health Service. One flock was located at 2500 North Redwood Road, Salt Lake City, and the other at the manager's residence at the Farmington Bay Waterfowl Management Area. A young flock of chickens was provided in 1963, 1964, and 1965. At the end of the mosquito season, in October or November, blood samples were taken from the chickens in the flocks and tested by the Disease Ecclogy Section for the presence and incidence of antibodies of Western Equine Encephalitis (WEE) and St. Louis Encephalitis (SLE) virus. In 1965 blood samples were taken in August and again in October.

Biting Tabanidae. During 1964 and 1965 a study was conducted to obtain information on the biology and control of the biting Tabanidae in the study areas. Special emphasis was placed on the oviposition sites and on the effects of water management on the development and emergence of these flies.

Crops. In 1963 the Salt Lake County District of the Soil Conservation Service developed a plan for the trial planting of waterfowl food and cover crops on the Lake Front Gun Club. In 1964 this plan was put into operation. The site was prepared by leveling the land and constructing border dikes on the contour at about 50 foot intervals. Wild millet (*Echinochloa crusgalli*) seed was broadcast in the basins at the rate of 25 pounds per acre. The border dikes were seeded with tall wheat grass (10 pounds per acre) and yellow sweet clover (2 pounds per acre). A pump was installed for pumping irrigation water from an adjacent marsh pond.

A similar trial planting was undertaken at the adjacent North Point Gun Club. Japanese millet (*Echinochloa crusgalli* var. *frumentacea*) was planted in this experiment.

Japanese millet, corn, milo, and sudan grass were planted on the Farmington Bay Waterfowl Management Area.

In 1965 Japanese millet was substituted for wild millet on the Lake Front Gun Club. Tall wheat grass and yellow and white sweet clover were planted on some of the Lake Front Club dikes.

A complete description of the trial planting is presented in the 1964 Annual Report (Rees *et al*. 1964).

MOSQUITOES PRESENT IN THE STUDY AREA
(Listed in Approximate Order of Abundance)

Culex tarsalis Coquillet: Both the larvae and adult stages of this species are widely distributed and seasonally abundant in the study area and in similar situations throughout Utah. Culex tarsalis overwinters in the adult stage. The eggs are laid in rafts of the surface of permanent, semi-permanent, or temporary bodies of water, and several broods are produced each year. The adults are active from dusk to dawn and the female feeds on a wide range of hosts including birds, other wild and domestic animals, and man. Culex tarsalis is reported to be the chief vector of Western Equine Encephalitis (WEE) virus in Utah. The flight range of C. tarsalis is approximately ten miles.

Aedes dorsalis (Meigen): Both the larvae and adults of this species are abundant and widely distributed in the study areas. The larvae, when other requirements are suitable, are produced in irrigated pastures, surface drainage pools and other areas which are temporarily flooded. Several broods are produced per year. The females readily attack man and are vicious biters, attacking during the day or night but are most active during the evening hours. They are strong fliers and are commonly found twenty miles or more from their emergence sites. Aedes dorsalis overwinters in the egg stage and the eggs may remain viable for several years.

Culiseta inornata (Williston): The larvae and adults are abundant and widely distributed in the study areas. This is a common species in Utah and the larvae are found in a wide variety of permanent and semi-permanent water. The eggs are deposited in rafts on the water surface and several generations are produced per year. The females attack man but seem to prefer larger animals. It is reported that C. inornata has been found naturally infected with the virus of Western Equine Encephalitis and has been shown in the laboratory to be capable of transmitting the virus. Evidence is now accumulating that seems to indicate that this species is important in maintaining the virus in the wild animal reservoir. The overwintering stage is the adult female. Larvae may possibly survive the winter under certain conditions.

Culex erythrothorax Dyar: This species was collected in the larval and adult stages and is widely distributed in the study areas. It was especially abundant in 1965. Large permanent marshes containing considerable vegetation appear to be preferred for larval development of this species. Larvae have been reported to survive the winter and this species may overwinter in this stage. During this study the larvae have been collected each month except March. In 1965, fourth instar larvae were collected in April. These mosquitoes generally attain their population peaks during the autumn months, but in 1965 they were also extremely numerous during July and August. The adults lay their eggs in rafts on the water surface and there are several broods per year. The females are vicious biters and are a severe nuisance in certain areas, especially in the late summer and fall.

Culex pipiens Linnaeus: This species was collected in both the adult and larval stages. It is widely distributed and abundant in Utah but was not particularly abundant in the study areas. The larvae are found in a wide variety of natural sites and in artificial containers in the valley areas. Although the females do not readily bite man in this area, the adults enter houses and constitute an annoyance. It has been reported that Western Equine and St. Louis Encephalitis virus have been isolated from wild specimens. The eggs of this species are laid in rafts on the water surface and several broods per year are produced. The overwintering stage is the adult female.

Aedes nigromaculis (Ludlow): Adult specimens of this species were taken in light trap and bite count collections but the larvae were not collected in the study areas. This is a multi-brooded species with the larvae found principally in irrigated pastures and in pools produced by irrigation flood water. The females are strong fliers and vicious biters. *Aedes nigromaculis* overwinter in the egg stage.

Aedes fitchii (Felt and Young): This species was collected in the larval stage from one sampling station in the study area. It is a single brooded species. The larvae develop in a wide variety of situations. The adult females bite day or night but are not generally sufficiently abundant to constitute an annoyance to man. *Aedes fitchii* overwinter in the egg stage.

Aedes vexans (Meigen): A few adult specimens of this species were collected in the car trap on the study areas. *Aedes vexans* is a multi-brooded species with the larvae occurring largely in overflow pools near streams in lower river valleys. *Aedes vexans* is a widely distributed important pest mosquito in Utah but was not abundant in the study areas. It overwinters in the egg stage.

Anopheles freeborni Aitkin: A few adult specimens of this species were taken in light trap samples. *Anopheles freeborni* is the most important vector of malaria in the Western United States. The eggs are laid singly on the surface of the water and there are several broods per year. The larvae are generally found in clear fresh water pools exposed to sunlight. The adult enters homes and animal shelters and readily bites at dusk and at dawn. This species overwinters as adults.

INDIVIDUAL SAMPLING STATIONS

1. Lake Front Gun, Fur and Reclamation Club.

Sampling Station 1. The vegetation is principally salt grass (Distichlis stricta). The water tends to fluctuate throughout the season. A rapid seasonal drawdown type of water management was used and a dike was constructed along one margin to facilitate in holding water out of this area. With this type of water management, the larval index was reduced from 14.7 in 1962 to 3.8 in 1964. In 1965 the dike broke in several places and there was considerable reflooding which resulted in a 1965 larval index of 12.3 (Appendix Table No. 5). The mosquitoes produced were primarily A. dorsalis. The nesting success was relatively low. Four nests were destroyed by flooding in 1965 indicating that nesting would be more successful if there were better control of the water. Ducks will readily utilize salt grass vegetation for nesting if it has not been flooded. With rapid seasonal drawdown water management, this type of an area can be developed as a nesting area for waterfowl with low mosquito production.

Sampling Station 2. The vegetation is primarily salt grass. The water fluctuates during the season but is more stable and is deeper than the water on Station 1. A gradual seasonal drawdown type of water management was used except during 1965 when it was permanently flooded. Through this type of management the larval index was reduced from 11.2 in 1962 to 0.2 in 1964. With permanent flooding in 1965 the larval index increased to 6.5 (Appendix Table No. 5). Although Stations 1 and 2 have the same type of vegetation, the larval densities were lower in Station 2 where water was deeper and more stabilized (Appendix Table No. 4). The mosquitoes produced on Station 2 were largely the more permanent water type. No duck nests were found on Station 2 although there was heavy coot nesting with 2.8 successful nests per acre. There were some duck nests in the clumps of olney's bulrush (Scirpus olneyi) bordering this station. This bulrush is encroaching upon the salt grass and the water management program is probably responsible for this change.

Sampling Station 6. The vegetation is a mixture of salt grass, olney's bulrush, and alkali bulrush (Scirpus paludosus). A gradual seasonal drawdown type of water management was used. The water was lowered with the decreasing water supply as the summer progressed with the level at which the water was held depending upon the water available. In 1965 the water level was appreciably higher than the two previous years. With this type of water management the larval index on this station was reduced from 8.3 in 1962 to 0.92 in 1964. The index raised to 5.4 in 1965 with the increased water level. The maximum water level in this station remained below 8 inches. The larval densities on this station were quite similar to those on Station 2. Most of the larvae were found in the salt grass fringe areas. The productivity for duck nests was 0.88 successful nests per acre. The alkali bulrush found in the area is an excellent food plant for waterfowl.

Sampling Station 7. The vegetation is mixed salt grass and alkali bulrush. The water tended to fluctuate during the season but the fluctuation was largely confined to the unvegetated alkali flat rather than the vegetated portion of the station. A gradual seasonal drawdown type of water management was applied. The larval index remained fairly constant throughout the four-year study (Appendix Table No. 5) and the mosquito production was consistently low (Appendix Table No. 4). The mosquitoes are a mixture of the flood water and permanent water species. The nesting success for ducks was poor (0.4 successful nests per acre) but was good for coots (2.9 successful nests per acre). Considerable food for waterfowl was produced on this station from the alklai bulrush vegetation. The alkali bulrush is gradually replacing salt grass as this station.

Sampling Station 8. The vegetation is mixed with olney's bulrush predominating and lesser stands of cattail (*Typha* sp.), hardstem bulrush (*Scirpus acutus*), salt grass and alkali bulrush. A gradual seasonal drawdown type of water management was used. The larval index was reduced from 6.0 in 1962 to 0.8 in 1964. with this management. In 1965 this station was flooded during most of the mosquito season, the larval index went up to 7.7 (Appendix Table No. 5). In 1965 the principal mosquito species was *C. erythrothorax* whereas in previous years *C. tarsalis* was the dominant species. The mosquito production on this station was consistently low averaging only .07 larvae per dip in 1964 (Appendix Table No. 4). The nesting success for ducks was highest on Station 8 for the Lake Front Club with 5.0 successful nests per acre. The majority of the nests were constructed in the olney's bulrush and were built above the water. Seven species of ducks were found nesting in this station. Salt grass is being replaced by emergent vegetation species and cattails are gradually increasing in abundance in this area. The emergent marsh vegetation is gradually encroaching upon the open water areas and some method of vegetation control will probably be necessary to maintain a desirable interspersion of vegetation and open water.

The repair of the dike on the lower end of this station has greatly facilitated the water management and has helped to change this area from high to low or moderate mosquito production. No flood water mosquitoes were found on this station in 1965.

Sampling Station 9. The vegetation is mixed with olney's bulrush dominant and salt grass along the edges in the shallower water. A permanent flooding type water management program was used. The larval index remained fairly constant during the four-year study (Appendix Table No. 5) and the average mosquito production was consistently low (Appendix Table No. 4). There was some fluctuation of the water in the salt grass edges and *A. dorsalis* larvae were found there. Only Culex and Culiseta larvae were found in the stabilized waters. The water on Station 9 was generally deeper than on Station 8 and the result was less mosquito production when both areas remained flooded (9 - 0.34 and 8 - 0.54 average larvae per dip). Most of the larvae were found in the shallow edges of Station 9. The area productivity for ducks was 1.02 successful nests per acre , with 4.9 successful coot nests per acre. The deeper water is probably a factor in reducing the duck nesting and increasing the coot nests. Olney's bulrush has replaced salt grass as the principal vegetation on this station since 1963.

Sampling Station 10. The vegetation is principally salt grass mixed with olney's bulrush and other moist soil vegetation. A permanent flooding type water management was applied. With this management the seasonal larval index was reduced from 4.2 in 1962 to 0.1 in 1964 (Appendix Table No. 5). The index increased to 1.9 in 1965. The mosquito production was lower than other stations such as 1 and 2 with similar vegetation. The stabilized water conditions with relatively deep water (generally 8 to 14 inches) probably accounted for this lower productivity. The mosquitoes produced were almost entirely Culex and Culiseta, the permanent water mosquitoes. Area productivity for ducks was low with 0.83 successful nests per acre. Nesting was a little higher for coots with 1.6 successful nests per acre.

Olney's bulrush has increased in this station from 3.6% in 1963 to 25% in 1965. Salt grass has decreased from 81.9% to 65% during this period.

2. Farmington Bay Waterfowl Management Area.

Sampling Station 2. The principal vegetation is alkali bulrush with some salt grass and other minor species. The water level was fairly stable although there was some fluctuation and some periods when the area became completely dry. The water management technique was a gradual seasonal drawdown. The larval index was reduced from 2.6 in 1962 to .05 in 1964 and increased to 0.1 in 1965 (Appendix Table No. 5). The larval densities were quite low during the entire four-year study (Appendix Table No. 4) with an overall average of .02 larvae per dip in 1964. Area productivity for ducks was 2 successful nests per acre. The percentage of salt grass on this station decreased during the period 1963 to 1965.

Sampling Station 6. The principal vegetation on this station is cattail with lesser amounts of salt grass and a few other moist soil plants. A gradual seasonal drawdown type water management was used except during 1965 when it remained flooded during the entire mosquito season. The larval index was reduced from 16.8 in 1962 to .07 in 1965 with this type management. This station was among the highest stations in mosquito production on Farmington Bay in 1962 with an average larval density of 3.81 larvae per dip and was the lowest station in 1965 with an average larval density of .006 larvae per dip (Appendix Table No. 4). Some nesting activity was observed but it was largely limited to coots and red head ducks both of which are able to nest in areas with fairly deep water. Cattail is not considered a desirable plant for nesting or food and in many marsh areas becomes a problem by replacing more desirable vegetation types.

Sampling Station 7. The vegetation on this station is a mixture of salt grass and alkali bulrush with lesser amounts of other moist soil plants. A flood irrigation type water management was applied. A continuous shallow flow of water moved over the area during most of the season. The amount of water and area covered decreased with the decrease in water supply as the season progressed. The larval index was reduced from 3.9 in 1962 to 0.3 in 1964 and increased to 4.7 in 1965 when the station was irrigated for a longer period of time than in previous years (Appendix Table No. 5). The larval density was fairly low in all four years of study and reached a low of an average of .03 larvae per dip in 1964. The larvae were almost completely confined to the salt grass areas and were found largely in small pockets or depressions where the water movement was limited. The productivity for ducks was the highest for Farmington Bay with 5.2 successful nests per acre. Great numbers of avocets, stilts and other shore birds also used this site for nesting. The nests were constructed largely of a mixture of the vegetations present and were located on the slightly elevated areas near the water. The alkali bulrush produced large amounts of food for the waterfowl. This type of an area could become a problem area in mosquito production if the irrigation results in establishing salt grass instead of alkali bulrush. More research needs to be done on the factors involved in the growth and distribution of marsh vegetation.

Sampling Station 8. The vegetation is principally salt grass mixed with some alkali bulrush. The water management employed was a rapid seasonal drawdown. With this type of management the larval index was reduced from a high of 14.6 in 1963 to a low of 4.1 in 1964 (Appendix Table No. 5). In 1965 the seasonal index increased to 8.6 due to reflooding in August before the end of the mosquito season. Larval densities were reduced from a high of a seasonal average of 2.48 larvae per dip in 1962 to an average of 0.5 larvae per dip in 1964 (Appendix Table No. 4). Area productivity for ducks was low with 0.72 successful duck nests per acre. The alkali bulrush produced some food for the waterfowl.

Sampling Station 10. The vegetation was a mixture of salt grass, alkali bulrush and cattail. A gradual seasonal drawdown type water management was attempted but was difficult to operate because of the flatness of the terrain, and the lack of natural or constructed high areas to delineate the impounded area. The seasonal larval index was reduced from 6.7 in 1962 to 2.7 in 1964 and increased to 5.8 in 1965 (Appendix Table No. 5). The average larval density remained fairly constant for the entire four years with a high of an average of .48 larvae per dip in 1962 and 1965 and a low of 0.22 larvae per dip in 1964. Most of the larvae were found in water depths of 4 to 8 inches. Few larvae were found in depths less than 4 inches. The area productivity for ducks was 0.22 successful ducks per acre, the lowest on Farmington Bay. The nesting habitat could probably be considerably improved by maintaining the water level at a lower depth so that the ducks could better utilize the salt grass habitat.

Sampling Station 14. The vegetation is a mixture of olney's bulrush, alkali bulrush and cattail. During the season the water tends to fluctuate in depth but not in the size of area. The water management technique employed was permanent flooding. The seasonal larval index decreased from 17.8 in 1962 to 0.5 in 1965 (Appendix Table No. 5).

The average larval density also showed a reduction from a seasonal average of 1.76 larvae per dip in 1962 to 0.5 larvae per dip in 1965. Most of the larvae were found in the clumps of olney's bulrush. In 1964 and 1965 this bulrush was cropped below the water level by the muskrats and afforded much less protection to the larvae than had the undisturbed bulrush. The area productivity for waterfowl was 2.0 successful nests per acre. Food production was good and the area was utilized by the birds for all activities.

C. Wheeler Machinery Company Test Area

Sampling Station 1. This station was leveled and planted into barley. Sprinkle irrigation was used for watering the crop. Future plans call for planting this station into permanent pasture. No mosquito larvae were found on this station during the study.

Sampling Station 2A. The principal vegetation was Eleocharis sp. This station was leveled for planting and the larval index dropped from 0.3 in 1963 to 0 in 1964 and 1965.

Sampling Station 2B. The vegetation was similar to Station 2A. Leveling was started on this station but small pot holes were created and mosquito production increased from a larval index of 0.4 in 1963 to an index of 1.0 in 1964 and 0.9 in 1965. Completion of the land leveling should eliminate mosquito production on this station.

Sampling Station 3. This station was used principally as pasture for livestock and remained unimproved during most of the study. Leveling operations were started during the summer of 1965. Through elimination of standing water, the larval index was reduced from 0.7 in 1963 to 0 in 1965.

Sampling Station 4. This station consists of the upper edge of a water storage reservoir. The slope is fairly steep and fluctuation in water depth results in very little fluctuation in the area. Mosquito production was limited to a very narrow interface of water and upland vegetation. No water management was attempted on this station. Keeping the edge free of vegetation would probably eliminate the mosquito production.

Sampling Station 5. This station consists of the lower edge of the reservoir mentioned under Station 4. This edge was abrupt and free of vegetation. No mosquito larvae were found in three years of sampling.

Sampling Station 6. This station consists of the upper edge of another reservoir. The slope was much more gradual than that of the two previous stations and the mosquito production was higher. No water management was practiced on this station but mosquito production could be reduced or eliminated by physical modification of the shoreline to make an abrupt edge.

Sampling Station 7. Water flowing onto the alkali flat from the above mentioned reservoirs sometimes flooded Station 7 which is vegetated with salt grass. Summer precipitation has also been sufficient at times to create a mosquito problem on this station. In 1965 this station was flooded five different times during the mosquito season. No water management was practiced on this station. Mosquito production on Station 7 could be reduced or eliminated by proper ditching and drainage.

The above stations on the Wheeler Area are on land that is being developed for agricultural purposes. Stations 8 through 16 are located in the area being developed for wildlife units.

Sampling Station 8. The principal vegetation consisted initially of salt grass. In 1965 this station was permanently flooded and the salt grass is being replaced by submergent marsh vegetation. This permanent flooding has reduced the larval index from 1.8 in 1963 and 2.2 in 1964 to .06 in 1965. In 1963 an average of 8 larvae per dip was found on this station. In 1965 larvae were found only twice with the highest density an average of 0.05 larvae per dip. Before flooding no waterfowl activities were observed on this station but during 1965 this area was used extensively by ducks, geese and other waterfowl for feeding and loafing.

Sampling Station 9. The principal vegetation is salt grass. No water management was applied on this station and the larval index remained quite constant for the three-year period.

Sampling Station 10. This station is located along the edge of a storage pond for waterfowl. The shoreline is fairly gradual and in 1963 there was considerable fluctuation in water levels resulting in mosquito larvae attaining an average of 12.0 per dip during one week in September. In 1964 and 1965 the water level was much more constant and there was no mosquito production during 1965. This area was used extensively by waterfowl in courting, feeding and loafing activities.

Sampling Station 11. This station consists of a shallow vegetated depression into which water seeped from the above mentioned pond. The larval index increased from 0.1 in 1963 to 5.0 in 1965. The mosquitoes consisted almost exclusively of *C. tarsalis*. The increased length of time of flooding of this station resulted in the increase in the larval index. In 1963 this station was dry after the third week in June but in 1964 and 1965 it remained flooded throughout the season. Ditching to dispose of the seepage water would reduce or eliminate this mosquito production. This station was too small to make it of value for utilization by waterfowl.

Sampling Station 12. The principal vegetation is salt grass with other minor moist soil plants. The larval index increased from 1.1 in 1963 to 3.5 in 1965. This increase was the result of a greater length of time that water remained on this station in 1965. There is no means of water removal for this station other than evaporation. Adequate ditching is needed for surface water drainage, in years of heavy precipitation. No waterfowl utilization was observed on this station.

Sampling Stations 13 and 14. These stations consist of old salt drying beds which have been converted to storage reservoirs. Vegetation is sparse but some alkali bulrush is beginning to appear on the edges and sago pond weed is beginning to grow in the deeper areas. There was no mosquito production on Station 13 and larvae were found only once on 14 during the three years of sampling. Waterfowl courting and loafing activities were observed on these stations.

Sampling Station 15. This station was discontinued after the first year.

Sampling Station 16. This station consisted of an area flooded with water from a flowing well. In 1964 part of the area was filled with soil and the size reduced. A ditch channeled some of the water into Station 8 but the ditch was too small to effectively remove all of the water. Adequate ditching would considerably reduce mosquito production. No waterfowl utilization of this station was observed.

Plans have been developed by the Soil Conservation Service for development of the wildlife part of the Wheeler Test Area. These plans include diking, leveling, planting, irrigation and construction of water management structures for control of waters on each individual unit. It is planned for future study to observe the effects this land development has on mosquito production. Mosquito abatement is one of the factors being considered in the development of this wildlife area.

MEASUREMENT OF WATER THROUGH SPILL BOXES

By M. T. Wilson and W. V. Iorns

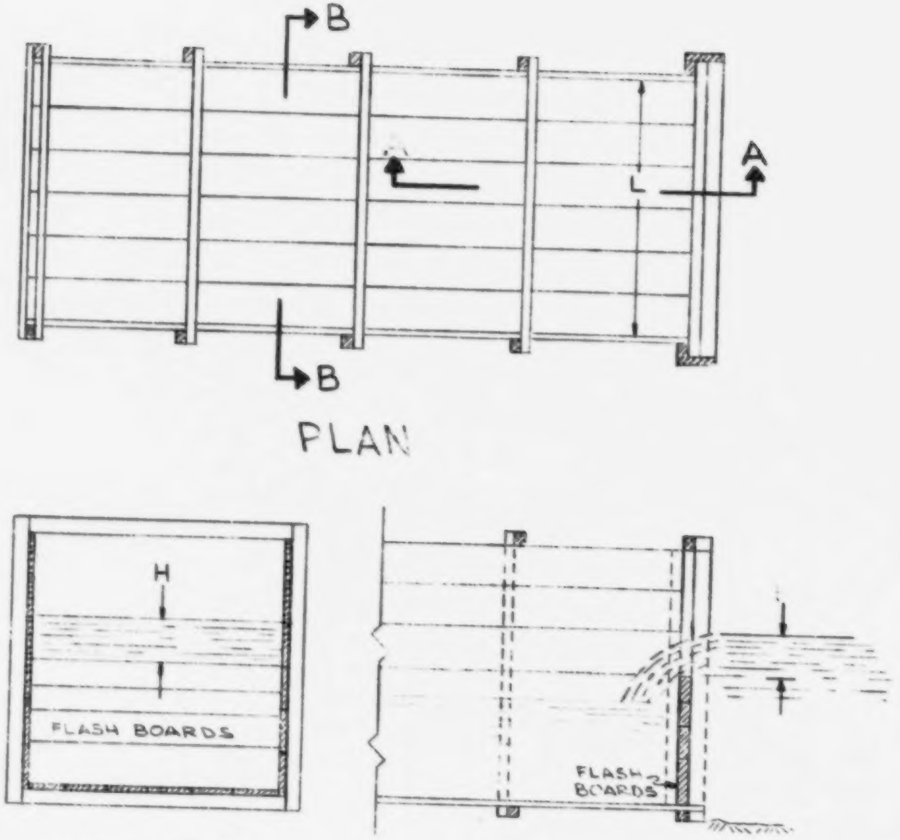
In the release and control of water flowing through units of wildlife refuge projects, the spill box is the usual facility used. This type of structure has several desirable features when compared to other means of regulating water passing through the several units of a wildlife project. A minimum amount of time is required in making the necessary adjustments in order to maintain a relative constant water level or water depth. As varying amounts of water enter the unit the stage increases or decreases and thus the discharge through the spill box changes rapidly to adjust for the changing water supply. Relative few adjustments are necessary in the number of flashboards in the spill boxes for the ordinary changes in water supply. During flood years most or all of the flashboards can be removed, thus releasing large quantities of water to prevent flooding of areas that should not be covered by water and for the protection of dikes and other property. It is desirable that water levels not change more than a few inches with changing water supply; therefore, flashboards for the upper section in the spill box should be made of 2" x 4" material while the lower planks can be cut from 2" x 6" material or wider, depending on the normal depth of water at the entrance to the structure. The lower, wider planks will normally be removed or replaced only at the beginning or end of the season or during flood periods.

Normal operation

Although the spill box was not designed to measure water, it can be used for that purpose with a reasonable degree of accuracy (plus or minus 10 percent) when proper hydraulic principles are applied. One of the principal structures for measuring water is the suppressed weir. The spill box with flashboards approaches the design of this structure and the formula $Q = 3.36\ L\ H\ 3/2$ can be applied with some adjustments. Figure 1 shows the hydraulic elements necessary for computing the discharge, H is the effective head of water flowing over the crest or flashboards. Since the nappe of the water surface directly above the flashboards is lower than the effective head (H), the head must be measured some distance (not less than 3 feet) above or to the side of the structure so that the measured depth is not affected by the curve produced by the falling water. A permanent gage can be installed for direct readings of the water surface; however, if this procedure is followed it will also be necessary to determine the gage reading for the top of the flashboards which would require a carpenter's level or an engineer's level. A more practical method of obtaining the effective head (H) over the flashboards is to construct a measuring rod as shown in figure 2. By placing a rod on the top of the flashboards, a direct reading of the effective head can be obtained from scale A by observing the height of pileup of water against the face of the scale. The pileup compensates for any velocity of approach and curvature of the nappe above the flashboards. As the water entering the spill box and flowing over the flashboard may not be suppressed at the sides, the length (L) of the flashboard may need to be decreased by about 2 inches (see Fig. 1). For practical and immediate use in the field, the (a) column in table 1 gives the discharge for each foot of length (L) and for varying heads (H).

Emergency Operation

When it is necessary to move large quantities of water through or from a refuge area by removing all of the flashboards, it is still practical to make measurements of the discharge but different hydraulic principles are involved. Under this condition the formula $Q = 2.7\ LH\ 3/2$ applies when there is free flow through the spill box.

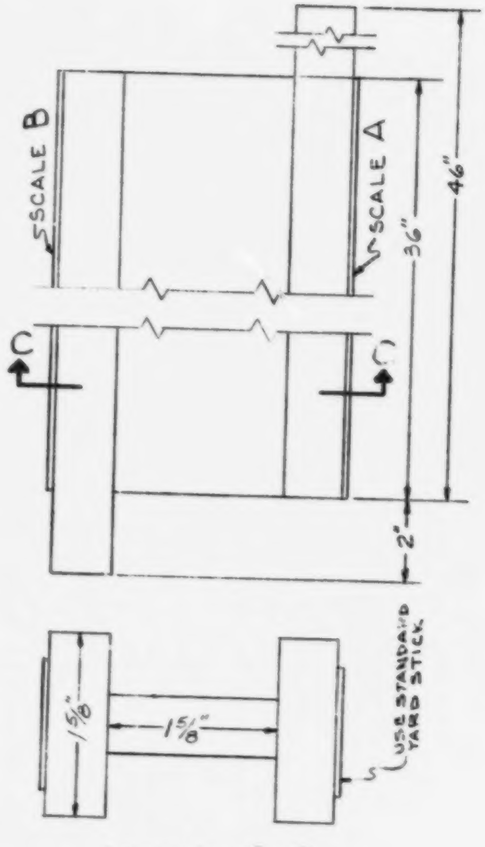

B
B
A
L
H
FLASH BOARDS
FLASH BOARDS

PLAN

SECTION B-B

SEC A-A

SPILL-BOX WITH FLASH BOARDS
FIGURE 1


SCALE B
SCALE A
C
C
36"
46"
2"
1 5/8"
1 5/8"
USE STANDARD YARD STICK

SECTION C-C

MEASURING ROD
FIGURE 2

Again, the most practical method of obtaining the head (H) is by use of the measuring rod previously described. The rod is held at the upper end and near the middle of the spill box when obtaining a reading of head (H) from scale A. The width (distance across the flume) should, if necessary, be slightly adjusted for side contraction as previously described. If the upstream bottom edge of the flume is rounded or is not above the ground level at the entrance, the discharge taken from table 1, column (c) should be increased by as much as 10 percent depending on the degree of roundness or the proportion of width not above the ground level.

Partially submerged spill box

At some installations the head of water at the lower end or outlet of the spill box will be high enough to cause backwater or submergence for part of the cross-sectional area of the water flowing over the flashboards. Under this condition, two computations are required, one for the submerged area formula $Q = 4.9\ AH\ 1/2$, and the second for the free-flowing area, formula $Q = 3.36\ LH\ 3/2$. Again, the measuring rod should be used to obtain the head (H) for the free-flowing area by subtracting the scale B reading from the scale A reading. This is also the effective head for the submerged area. The depth of the submerged area is the reading on scale B. The discharge from table 1 columns (a) and (b) are added to obtain the total discharge for each foot of length (L) which should be measured as previously discussed.

Design of spill boxes

The attached table can be used to determine the width of spill box or the number of spill boxes required to pass a designated discharge through a unit of wildlife refuge project. Example: If it is desirable to maintain a water level that will not fluctuate more than 4 inches without changing the flashboards and the inflow to the unit ranges from about 2 cfs to 25 cfs, a spill box with a width of 40 feet or five spill boxes with widths of 8 feet would be required. However, if the project is operated with maintenance personnel so that flashboards will be removed and replaced as necessary to maintain a constant level, a large quantity of water can be passed with little change in water level. For example, assume a 9-foot spill box with an effective head of 4 inches over two 2" x 6" and two 2" x 4" flashboards. Under this condition the discharge would be 5.6 cfs. Removal of the two 2" x 4" flashboards would increase the discharge to 25.7 cfs with the same water level. With removal of the other two 2" x 6" flashboards the spill box would pass about 61 cfs, providing there is no backwater.

Computation of Free-Flowing and Partially Submerged Spill Box Discharge

OVERFLOW FLASHBOARDS - FREE FLOWING

Hold rod on center of flashboards and read height of the splash on pileup in inches and fractions on the front yardstick. This is the effective head (static plus velocity head). Look up in the Free Flow column the discharge in cfs per foot of flashboard length. Multiply this by the length of flashboard crest in feet (length less end contractions if any) for total discharge in cfs.

OVERFLOW FLASHBOARDS - PARTIALLY SUBMERGED

Measure height of splash or pileup in inches and fractions on front yardstick with rod held on center of flashboard crest, call this "H". Measure back head on rear yardstick in inches and fractions, call this "B". (If flashboard is free flowing there will be no backhead.) Measure length of flashboard in feet. Call this "L".

Discharge for free-flowing part

H-B = effective head. Look up in Free-Flow column the discharge per foot of length and multiply this by length of flashboard in feet to obtain free-flow discharge.

Discharge for submerged part

B = height of opening in inches.
L = length of flashboard in feet.
H-B = effective head. Look up in submerged column the discharge in cfs for each foot of flashboard length for this head. Multiply this by B and L to obtain sumberged discharge.

Add discharge of free-flowing part and discharge of submerged part to obtain total discharge of spill box.

OPEN FLUME

Hold rod on center of upstream end of flume and read height of the splash on pileup in inches and fractions on the front yardstick. This is the effective head (static plus velocity head). Look up in the Flume column the discharge in cfs per foot of flume width. Multiply this by the width of flume crest in feet (width less end contractions if any) for total discharge in cfs.

Free-Flow, Partially-Submerged Weir and Flume Discharge in Cubic Feet Per Second

Head in Inches	Free Flow (a)	Sub-merged (b)	Flume (c)	Head in Inches	Free Flow (a)	Sub-merged (b)	Flume (c)	Head in Inches	Free Flow (a)	Sub-merged (b)	Flume (c)
1/2				1 3/4	.156	.154	0.151	3	.384	.203	.337
5/8				1 7/8	.173	.160	.166	3 1/8	.413	.207	.358
3/4				2	.192	.166	.184	3 1/4	.444	.210	.381
7/8				2 1/8	.216	.170	.201	3 3/8	.475	.214	.402
1	0.048	0.118	0.064	2 1/4	.240	.175	.220	3 1/2	.504	.218	.426
1 1/8	.065	.124	.078	2 3/8	.264	.180	.238	3 5/8	.533	.222	.448
1 1/4	.084	.130	.090	2 1/2	.288	.184	.256	3 3/4	.564	.226	.470
1 3/8	.101	.136	.105	2 5/8	.312	.189	.277	3 7/8	.595	.230	.496
1 1/2	.120	.142	.119	2 3/4	.336	.194	.296	4	.624	.234	.519
1 5/8	.139	.148	.134	2 7/8	.360	.198	.317	4 1/8	.658	.237	.545

Free-Flow, Partially-Submerged Weir and Flume Discharge in Cubic Feet Per Second--cont.

Head in Inches	Free Flow (a)	Sub-merged (b)	Flume (c)	Head in Inches	Free Flow (a)	Sub-merged (b)	Flume (c)	Head in Inches	Free Flow (a)	Sub-merged (b)	Flume (c)
4 1/4	.691	.240	.569	8 1/2	1.932	.339	1.608	15 1/2	4.764	.456	3.965
4 3/8	.722	.244	.595	8 5/8	1.978	.341	1.646	15 3/4	4.877	.460	4.058
4 1/2	.756	.247	.620	8 3/4	2.023	.344	1.680	16	4.992	.463	4.155
4 5/8	.790	.250	.645	8 7/8	2.066	.346	1.719	16 1/4	5.112	.467	4.254
4 3/4	.821	.253	.673	9	2.112	.349	1.754	16 1/2	5.232	.470	4.353
4 7/8	.854	.257	.698	9 1/8	2.158	.351	1.789	16 3/4	5.352	.474	4.453
5	.888	.260	.727	9 1/4	2.203	.354	1.828	17	5.472	.478	4.554
5 1/8	.898	.263	.753	9 3/8	2.246	.356	1.864	17 1/4	5.592	.289	4.656
5 1/4	.955	.266	.780	9 1/2	2.292	.358	1.903	17 1/2	5.712	.293	4.753
5 3/8	.986	.269	.810	9 5/8	2.338	.360	1.939	17 3/4	5.832	.296	4.856
5 1/2	1.020	.272	.837	9 3/4	2.381	.363	1.976	18	5.952	.492	4.960
5 5/8	1.054	.275	.867	9 7/8	2.426	.365	2.016	18 1/4	6.077	.495	5.060
5 3/4	1.085	.278	.895	10	2.472	.367	2.053	18 1/2	6.204	.499	5.160
5 7/8	1.118	.281	.919	10 1/4	2.568	.372	2.131	18 3/4	6.331	.502	5.260
6	1.152	.284	.955	10 1/2	2.664	.376	2.210	19	6.456	.505	5.360
6 1/8	1.188	.287	.983	10 3/4	2.760	.381	2.290	19 1/4	6.588	.508	5.460
6 1/4	1.224	.290	1.015	11	2.856	.385	2.371	19 1/2	6.720	.512	[illegible]
6 3/8	1.260	.293	1.045	11 1/4	2.952	.390	2.456	19 3/4	6.852	.515	5.724
6 1/2	1.296	.296	1.077	11 1/2	3.048	.394	2.532	20	6.984	.518	5.775
6 5/8	1.332	.299	1.107	11 3/4	3.144	.398	2.615	20 1/4	7.123	.521	5.932
6 3/4	1.368	.302	1.138	12	3.240	.402	2.700	20 1/2	7.260	.524	6.037
6 7/8	1.404	.304	1.171	12 1/4	3.341	.406	2.818	20 3/4	7.397	.527	6.145
7	1.440	.307	1.202	12 1/2	3.444	.410	2.897	21	7.536	.530	6.250
7 1/8	1.478	.310	1.236	12 3/4	3.547	.414	2.968	21 1/4	7.675	.534	6.356
7 1/4	1.517	.313	1.267	13	3.648	.418	3.020	21 1/2	7.812	.537	6.466
7 3/8	1.558	.315	1.302	13 1/4	3.756	.421	3.132	21 3/4	7.949	.540	6.574
7 1/2	1.596	.318	1.334	13 1/2	3.864	.425	3.222	22	8.088	.544	6.685
7 5/8	1.634	.321	1.366	13 3/4	3.972	.429	3.317	22 1/4	8.227	.546	6.793
7 3/4	1.675	.324	1.402	14	4.080	.433	3.404	22 1/2	8.364	.550	6.900
7 7/8	1.714	.326	1.434	14 1/4	4.195	.437	3.496	22 3/4	8.501	.552	[illegible]
8	1.752	.329	1.471	14 1/2	4.308	.441	3.589	23	8.640	.556	7.182
8 1/8	1.798	.331	1.504	14 3/4	4.420	.445	3.679	23 1/4	8.779	.558	7.295
8 1/4	1.843	.334	1.537	15	4.536	.449	3.773	23 1/2	8.916	.562	7.409
8 3/8	1.886	.336	1.575	15 1/4	4.637	.452	3.869	23 3/4	9.053	.564	7.522
								24	9.192	.568	7.636

(a) Each foot of flashboard length
(b) Each foot of flashboard length and inch of backhead
(c) Each foot of flume width

Appendix Table 1

SPECIES OF MOSQUITO LARVAE
FOUND IN EACH SAMPLING STATION

		Lake Front Gun Club								Farmington Bay Wildlife Area						
		1	2	6	7	8	9	10	Total stations found	2	6	7	8	10	14	Total stations found
Aedes dorsalis	1962	X	X	X		X	X	X	6		X	X	X		X	4
	1963	X	X	X	X	X	X		6		X	X	X	X	X	5
	1964	X	X	X	X	X	X		6	X	X	X	X	X	X	6
	1965	X	X	X	X		X	X	6			X	X	X		3
Culiseta inornata	1962	X	X	X	X	X	X	X	7	X	X	X	X	X	X	6
	1963	X	X	X	X	X	X	X	7	X	X	X	X	X	X	6
	1964	X	X	X	X	X	X	X	7		X	X	X	X	X	5
	1965	X	X	X	X	X	X	X	7	X	X	X	X	X	X	6
Culex tarsalis	1962	X	X	X	X	X	X	X	7	X	X	X	X	X	X	6
	1963	X	X	X	X	X	X	X	7		X	X	X	X	X	5
	1964	X	X	X	X	X	X	X	7	X		X	X	X	X	5
	1965	X	X	X	X	X	X	X	7	X	X	X	X	X	X	6
Culex erythrothorax	1962	X	X	X	X	X	X	X	7						X	1
	1963								0						X	1
	1964							X	1			X				1
	1965	X	X	X	X	X	X	X	7	X		X		X	X	4
Culex pipiens	1962								0		X	X				2
	1963		X						1			X			X	2
	1964								0							0
	1965	X					X		2			X			X	2
Total number of species in each station		5	5	4	4	4	5	4		4	4	5	3	4	5	

Appendix Table 1
(continued)

SPECIES OF MOSQUITO LARVAE
FOUND IN EACH SAMPLING STATION

Wheeler Machinery Company Test Area

		1	2A	2B	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total stations found
Aedes dorsalis	1963		X	X				X	X	X		X		X				X	8
	1964			X	X	X			X		X		X	X		X		X	9
	1965			X				X	X				X	X				X	6
Aedes fitchii	1963																		0
	1964																		0
	1965			X															1
Culiseta inornata	1963		X	X	X	X		X		X	X	X	X	X				X	11
	1964			X	X			X		X	X		X	X				X	8
	1965			X					X	X			X	X				X	6
Culex tarsalis	1963		X	X	X	X		X		X	X	X	X	X				X	11
	1964			X	X	X		X		X		X	X	X	X			X	10
	1965			X		X		X	X	X	X							X	7
Culex erythrothorax	1963																		0
	1964									X									1
	1965					X		X	X		X		X						5
Culex pipiens	1963																		0
	1964					X													1
	1965							X					X						2
Total number of species in each station		0	3	4	3	5	0	5	4	4	4	3	5	3	1	0	1	3	

Appendix Table 2

NUMBER OF TIMES THE LARVAE OF EACH SPECIES WERE COLLECTED AT EACH STATION

Lake Front Gun, Fur and Reclamation Club

Station		Aedes dorsalis	Culiseta inornata	Culex tarsalis	Culex erythrothorax	Culex pipiens	Unidentified	No. times samples were made	Total times larvae were found*
1	1962	5	19	10	1	0	0	23	21
	1963	10	13	11	0	0	0	22	20
	1964	9	5	5	0	0	0	26	15
	1965	14	9	8	6	1	0	25	19
2	1962	2	18	7	1	0	1	24	23
	1963	3	17	9	0	1	0	22	18
	1964	4	5	3	0	0	1	26	10
	1965	5	12	8	5	0	2	24	18
6	1962	9	17	13	2	0	2	22	20
	1963	9	6	5	0	0	0	21	12
	1964	5	3	10	0	0	0	26	15
	1965	8	12	10	15	0	1	26	23
7	1962	0	10	11	2	0	1	18	17
	1963	9	2	3	0	0	0	21	11
	1964	6	3	4	0	0	0	26	9
	1965	4	6	8	10	0	1	24	18
8	1962	2	10	11	1	0	0	19	18
	1963	4	3	5	0	0	0	21	10
	1964	7	1	6	0	0	0	26	10
	1965	0	12	4	14	0	0	24	16

*This figure is not the total of each row since in many samples more than one species of larvae was found.

Appendix Table 2 (continued)

NUMBER OF TIMES THE LARVAE OF EACH SPECIES
WERE COLLECTED AT EACH STATION

Lake Front Gun, Fur and Reclamation Club (continued)

Station		*Aedes dorsalis*	*Culiseta inornata*	*Culex tarsalis*	*Culex erythrothorax*	*Culex pipiens*	Unidentified	No. times samples were made	Total times larvae were found*
9	1962	4	16	14	2	3	0	21	21
	1963	4	16	11	0	0	2	22	20
	1964	3	12	6	0	0	1	26	15
	1965	2	7	12	12	1	0	24	20
10	1962	1	17	7	1	1	0	18	17
	1963	0	17	11	0	0	0	21	19
	1964	0	10	4	1	0	1	26	14
	1965	2	9	5	4	0	1	24	13
Total No. Times	1962	23	117	81	10	4	4	145	137
	1963	39	74	55	0	1	2	150	110
	1964	34	39	42	1	0	3	182	88
	1965	35	67	55	66	2	5	171	127
Percentages	1962	16	81	56	7	3	3		95
	1963	26	49	37	0	0.6	1.4		73
	1964	29	33	36	0.8	0	1.5		48
	1965	20	39	32	39	1	3		74

*This figure is not the total of each row since in many samples more than one species of larvae was found.

Appendix Table 2 (continued)

NUMBER OF TIMES THE LARVAE OF EACH SPECIES
WERE COLLECTED AT EACH STATION

Farmington Bay Waterfowl Management Area

Station		*Aedes dorsalis*	*Culiseta inornata*	*Culex tarsalis*	*Culex erythrothorax*	*Culex pipiens*	Unidentified	No. times samples were made	Total times larvae were found*
2	1962	0	4	0	0	0	0	17	14
	1963	0	1	0	0	0	0	22	1
	1964	3	0	1	0	0	0	26	4
	1965	0	1	3	1	0	0	24	3
6	1962	1	12	5	0	2	0	17	14
	1963	5	16	6	0	0	0	22	17
	1964	1	7	0	0	0	1	26	9
	1965	0	3	1	0	0	0	24	4
7	1962	6	7	4	1	1	0	17	11
	1963	8	7	8	0	1	1	22	11
	1964	11	5	10	1	0	2	26	19
	1965	3	6	8	6	2	0	24	11
8	1962	4	11	6	0	0	0	17	11
	1963	9	15	12	0	0	1	22	17
	1964	4	6	5	0	0	2	26	10
	1965	3	4	1	0	0	0	24	6

*This figure is not the total of each row since in many samples more than one species of larvae was found.

Appendix Table 2 (continued)

NUMBER OF TIMES THE LARVAE OF EACH SPECIES
WERE COLLECTED AT EACH STATION

Farmington Bay Waterfowl Management Area (continued)

Station		*Aedes dorsalis*	*Culiseta inornata*	*Culex tarsalis*	*Culex erythrothorax*	*Culex pipiens*	Unidentified	No. times samples were made	Total times larvae were found*
10	1962	0	12	8	0	0	0	17	15
	1963	3	12	7	0	0	1	22	15
	1964	7	14	7	0	0	0	26	22
	1965	8	13	12	4	0	1	24	19
14	1962	0	10	1	3	2	3	17	13
	1963	1	8	8	2	1	4	22	13
	1964	2	1	4	0	0	0	26	7
	1965	0	1	6	2	1	0	24	7
Total No. times	1962	11	56	24	4	5	3	102	78
	1963	18	59	41	2	2	7	132	74
	1964	28	33	27	1	0	5	156	71
	1965	14	28	31	13	3	1	144	50
Percentages	1962	11	55	24	4	5	3		76
	1963	14	45	31	2	2	5		56
	1964	18	21	17	0.6	0	3		46
	1965	10	20	22	9	2	0.7		35

*This figure is not the total of each row since in many samples more than one species of larvae was found.

Appendix Table 2 (continued)

NUMBER OF TIMES THE LARVAE OF EACH SPECIES WERE COLLECTED AT EACH STATION

Wheeler Machinery Company Test Area

Station		*Aedes dorsalis*	*Culiseta inornata*	*Culex tarsalis*	*Culex erythrothorax*	*Culex pipiens*	Unidentified	No. times samples were made	Total times larvae were found*
1	1963	0	0	0	0	0	0	21	0
	1964	0	0	0	0	0	0	28	0
	1965	0	0	0	0	0	0	25	0
2A	1963	2	1	1	0	0	1	21	3
	1964	0	0	0	0	0	0	28	0
	1965	0	0	0	0	0	0	25	0
2B	1963	1	2	2	0	0	0	21	3
	1964	6	1	2	0	0	0	28	7
	1965*	1	2	1	0	0	0	25	5
3	1963	0	6	1	0	0	0	21	7
	1964	3	3	1	0	0	0	28	5
	1965	0	0	0	0	0	0	25	0
4	1963	0	1	4	0	0	0	21	5
	1964	3	0	5	0	1	0	28	7
	1965	0	0	4	1	0	0	25	5
5	1963	0	0	0	0	0	0	21	0
	1964	0	0	0	0	0	0	28	0
	1965	0	0	0	0	0	0	25	0
6	1963	3	1	6	0	0	0	21	8
	1964	0	0	5	0	0	0	28	5
	1965	1	0	9	1	1	0	25	10
7	1963	5	0	0	0	0	0	21	5
	1964	5	1	0	0	0	0	28	6
	1965	7	1	1	1	0	0	25	7
8	1963	3	5	1	0	0	1	21	9
	1964	0	6	7	2	0	0	28	9
	1965	0	1	1	0	0	0	25	2

*This figure is not the total of each row since in many samples more than one species of larvae was found. (*Aedes fitchii* were found four times in station 2B during 1965. They were found in 1% of the samples taken throughout the year in this area.)

Appendix Table 2 (continued)

NUMBER OF TIMES THE LARVAE OF EACH SPECIES
WERE COLLECTED AT EACH STATION

Wheeler Machinery Company Test Area (continued)

Station		Aedes dorsalis	Culiseta inornata	Culex tarsalis	Culex erythrothorax	Culex pipiens	Unidentified	No. times samples were made	Total times larvae were found*
9	1963	0	2	1	0	0	0	21	3
	1964	3	0	4	0	0	1	28	7
	1965	0	0	1	1	0	0	25	1
10	1963	2	4	4	0	0	0	21	4
	1964	0	0	4	0	0	0	28	4
	1965	0	0	0	0	0	0	25	0
11	1963	0	1	0	0	0	1	21	2
	1964	5	1	10	0	0	1	28	16
	1965	1	2	12	5	2	0	25	15
12	1963	1	2	2	0	0	0	21	3
	1964	8	1	1	0	0	2	28	10
	1965	8	1	1	0	0	0	25	8
13	1963	0	0	0	0	0	0	21	0
	1964	0	4	0	0	0	0	28	4
	1965	0	0	0	0	0	0	25	0
14	1963	0	0	0	0	0	0	21	0
	1964	1	0	0	0	0	0	28	1
	1965	0	0	0	0	0	0	25	0
16	1963	9	9	7	0	0	2	21	16
	1964	2	2	1	0	0	0	28	4
	1965	4	3	2	0	0	1	25	7
Total No. Times	1963	26	34	29	0	0	5	336	68
	1964	36	19	40	2	1	5	448	85
	1965	22	10	32	9	3	1	400	60
Percentages	1963	8	10	9	0	0	1		20
	1964	8	4	9	0.4	0.2	1		19
	1965	5	3	8	2	0.8	0.3		15

*This figure is not the total of each row since in many samples more than one species of larvae was found.

Appendix Table 3

TOTAL NUMBER AND PERCENTAGES OF SPECIES
OF MOSQUITO LARVAE COLLECTED WEEKLY

Lake Front Gun, Fur and Reclamation Club

Station		Total No. of larvae	*Aedes dorsalis*		*Culiseta inornata*		*Culex tarsalis*		*Culex erythrothorax*		*Culex pipiens*		Unidentified	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1	1962	1943	449	23	1009	52	480	25	10	0.5	0	0	0	0
	1963	1215	706	58	186	15	323	27	0	0	0	0	0	0
	1964	666	535	80	18	3	113	17	0	0	0	0	0	0
	1965	1835	1020	56	321	17.5	337	18.4	152	8.3	5	0.3	0	0
2	1962	1585	204	13	1178	74	76	5	6	0.4	0	0	121	8
	1963	246	21	9	149	61	73	30	0	0	3	1	0	0
	1964	48	20	42	15	31	9	19	0	0	0	0	0	0
	1965	967	193	21	193	21	221	24	360	39	0	0	0	0
6	1962	1383	540	39	451	33	340	25	29	2	2	0.1	21	2
	1963	659	503	76	113	17	41	6	0	0	0	0	3	1
	1964	194	76	39	9	5	109	56	0	0	0	0	0	0
	1965	1005	55	5	130	13	319	32	501	50	0	0	0	0
7	1962	395	0	0	135	34	211	53	2	0.5	0	0	47	12
	1963	273	227	83	19	6	24	9	0	0	0	0	3	1
	1964	511	403	79	14	11	51	40	0	0	0	0	0	0
	1965	346	20	5.7	34	10	80	23	210	61	0	0	2	1

ppendix Table 3 (continued)

TOTAL NUMBER AND PERCENTAGES OF SPECIES
OF MOSQUITO LARVAE COLLECTED WEEKLY

Lake Front Gun, Fur and Reclamation Club (continued)

Station		Total No. of larvae	*Aedes dorsalis*		*Culiseta inornata*		*Culex tarsalis*		*Culex erythrothorax*		*Culex pipiens*		Unidentified	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
8	1962	1047	18	2	193	18	831	79	4	0.4	0	0	1	0.1
	1963	105	16	15	8	8	81	77	0	0	0	0	0	0
	1964	127	62	49	14	11	51	40	0	0	0	0	0	0
	1965	1205	0	0	250	21	95	8	860	71	0	0	0	0
9	1962	530	9	2	325	61	166	31	9	2	0	0	21	4
	1963	477	93	19	234	49	145	30	0	0	0	0	5	1.0
	1964	346	118	34	70	20	156	45	0	0	0	0	2	0.5
	1965	387	2	0.5	65	17	42	11	274	71	2	0.5	0	0
10	1962	786	5	0.6	658	84	114	15	7	0.9	0	0	2	0.3
	1963	248	0	0	177	71	71	29	0	0	0	0	0	0
	1964	242	0	0	146	60	92	38	1	0.5	0	0	3	1.5
	1965	328	2	0.7	60	18	195	59.5	70	21.5	0	0	1	0.3
Totals	1962	7674	1225	16	3949	51	2218	29	67	0.9	2	0.03	213	0.3
	1963	3223	1566	49	886	27	758	24	0	0	3	0.09	10	0.26
	1964	2134	1214	57	303	14	607	28	1	0.05	0	0	9	0.4
	1965	6071	1292	21	1055	17.6	1289	21	2427	40	7	0.3	1	0.1
Grand Totals		19,102	5287	28	6193	32	4872	26	2495	13	12	0.01	233	1.0

Appendix Table 3 (continued)

TOTAL NUMBER AND PERCENTAGES OF SPECIES
OF MOSQUITO LARVAE COLLECTED WEEKLY

Farmington Bay Waterfowl Management Area

Station		Total No. of larvae	*Aedes dorsalis*		*Culiseta inornata*		*Culex tarsalis*		*Culex erythrothorax*		*Culex pipiens*		Unidentified	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
2	1962	398	0	0	375	94	22	6	0	0	0	0	1	3
	1963	15	0	0	15	100	0	0	0	0	0	0	0	0
	1964	10	9	90	0	0	1	10	0	0	0	0	0	0
	1965	17	0	0	1	7	11	63	5	30	0	0	0	0
6	1962	2367	4	0.2	1883	80	269	10	0	0	150	6	61	3
	1963	1531	282	18	1230	80	19	1	0	0	0	0	0	0
	1964	25	3	12	21	84	0	0	0	0	0	0	1	4
	1965	10	0	0	9	90	1	10	0	0	0	0	0	0
7	1962	567	190	34	348	61	27	5	0	0	2	0.4	0	0
	1963	230	98	43	71	31	57	25	1	0.4	0	0	3	1
	1964	472	217	46	21	4	223	47	2	0.4	0	0	9	1.9
	1965	709	278	39	51	7.2	135	19	238	33	7	1.8	0	0
8	1962	1083	192	18	602	56	289	27	0	0	0	0	0	0
	1963	2312	829	36	1165	50	293	13	0	0	0	0	25	1
	1964	846	93	11	354	42	355	42	0	0	0	0	44	5
	1965	1432	1427	99	4	0.8	1	0.2	0	0	0	0	0	0

Appendix Table 3 (continued)

TOTAL NUMBER AND PERCENTAGES OF SPECIES
OF MOSQUITO LARVAE COLLECTED WEEKLY

Farmington Bay Waterfowl Management Area (continued)

Station		Total No. of larvae	*Aedes dorsalis*		*Culiseta inornata*		*Culex tarsalis*		*Culex erythrothorax*		*Culex pipiens*		Unidentified	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
10	1962	904	0	0	713	79	187	21	0	0	0	0	4	0.4
	1963	324	181	56	84	26	56	17	0	0	0	0	3	0.9
	1964	469	216	46	235	50	18	4	0	0	0	0	0	0
	1965	902	114	13	412	46	265	29	111	12	0	0	0	0
14	1962	590	0	0	423	72	0	0	20	3	52	9	95	16
	1963	317	2	0.6	150	47	133	42	6	2	4	1.3	22	7
	1964	258	3	1	10	4	245	95	0	0	0	0	0	0
	1965	83	0	0	1	1	72	87	9	11	1	1	0	0
Totals	1962	5909	386	7	4344	74	794	13	20	0.3	204	3	161	2
	1963	4729	1392	29	2715	57	558	12	6	0.13	5	0.1	53	1.1
	1964	2080	541	26	641	31	342	40	2	0.1	0	0	54	3.0
	1965	3153	1819	58	478	15	485	15	363	12	8	0.3	0	0
Grand Totals		15,871	4138	26	8178	52	2679	17	391	3	217	1	268	2

Appendix Table 3 (continued)

TOTAL NUMBER AND PERCENTAGES OF SPECIES
OF MOSQUITO LARVAE COLLECTED WEEKLY

Wheeler Machinery Company Test Area

Station		Total No. of larvae	*Aedes dorsalis*		*Culiseta inornata*		*Culex tarsalis*		*Culex erythrothorax*		*Culex pipiens*		Unidentified	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1	1963	0	0	0	0	0	0	0	0	0	0	0	0	0
	1964	0	0	0	0	0	0	0	0	0	0	0	0	0
	1965	0	0	0	0	0	0	0	0	0	0	0	0	0
2A	1963	54	3	6	1	2	49	91	0	0	0	0	1	2
	1964	0	0	0	0	0	0	0	0	0	0	0	0	0
	1965	0	0	0	0	0	0	0	0	0	0	0	0	0
2B	1963	11	3	27	4	36	4	36	0	0	0	0	0	0
	1964	260	248	95	2	0.8	10	4	0	0	0	0	0	0
	1965*	141	6	0.4	4	0.3	1	0.1	0	0	0	0	0	0
3	1963	180	0	0	178	99	2	1	0	0	0	0	0	0
	1964	103	47	46	26	25	27	26	0	0	3	3	0	0
	1965	0	0	0	0	0	0	0	0	0	0	0	0	0
4	1963	18	0	0	3	17	15	83	0	0	0	0	0	0
	1964	84	6	7	0	0	78	93	0	0	0	0	0	0
	1965	17	0	0	0	0	16	94	1	6	0	0	0	0
5	1963	0	0	0	0	0	0	0	0	0	0	0	0	0
	1964	0	0	0	0	0	0	0	0	0	0	0	0	0
	1965	0	0	0	0	0	0	0	0	0	0	0	0	0
6	1963	108	12	11	0	0	96	89	0	0	0	0	0	0
	1964	51	0	0	0	0	51	100	0	0	0	0	0	0
	1965	203	1	0.5	59	29	124	62	9	4.4	10	5	0	0
7	1963	320	320	100	0	0	0	0	0	0	0	0	0	0
	1964	202	193	96	5	2	0	0	0	0	0	0	4	2
	1965	494	437	89	21	4.1	16	3	20	3.9	0	0	0	0

*130 *Aedes fitchii* larvae were collected from station 2B during 1965, constituting 99.2% of the total larvae collected at that station.

Appendix Table 3 (continued)

TOTAL NUMBER AND PERCENTAGES OF SPECIES
OF MOSQUITO LARVAE COLLECTED WEEKLY

Wheeler Machinery Company Test Area (continued)

Station		Total No. of larvae	*Aedes dorsalis*		*Culiseta inornata*		*Culex tarsalis*		*Culex erythrothorax*		*Culex pipiens*		Unidentified	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
8	1963	324	114	44	146	45	3	1	0	0	0	0	31	10
	1964	361	0	0	106	29	248	69	7	2	0	0	0	0
	1965	27	0	0	1	4	8	28	1	6	0	0	0	0
9	1963	16	0	0	11	69	4	25	0	0	0	0	1	6
	1964	258	180	70	0	0	76	29	0	0	0	0	2	1
	1965	0	0	0	0	0	0	0	0	0	0	0	0	0
10	1963	972	62	6	298	31	612	63	0	0	0	0	0	0
	1964	34	0	0	0	0	34	100	0	0	0	0	0	0
	1965	0	0	0	0	0	0	0	0	0	0	0	0	0
11	1963	15	0	0	14	93	0	0	0	0	0	0	1	7
	1964	900	420	47	4	0.4	459	51	0	0	0	0	17	2
	1965	949	15	2.1	10	0.9	737	78	173	17	14	2.0	0	0
12	1963	156	122	78	25	16	7	4	0	0	0	0	2	1
	1964	118	109	92	3	3	3	3	0	0	0	0	3	3
	1965	566	564	99.4	1	0.3	1	0.3	0	0	0	0	0	0
13	1963	0	0	0	0	0	0	0	0	0	0	0	0	0
	1964	32	0	0	0	0	32	100	0	0	0	0	0	0
	1965	0	0	0	0	0	0	0	0	0	0	0	0	0
14	1963	0	0	0	0	0	0	0	0	0	0	0	0	0
	1964	11	11	100	0	0	0	0	0	0	0	0	0	0
	1965	0	0	0	0	0	0	0	0	0	0	0	0	0
16	1963	332	83	25	150	45	91	27	0	0	0	0	8	2
	1964	128	123	96	2	2	3	3	0	0	0	0	0	0
	1965	188	86	46	84	45	15	7.4	0	0	0	0	3	1.6
Totals	1963	2506	749	30	530	33	883	35	0	0	0	0	44	0.2
	1964	2542	1337	53	[illegible]	5	1021	40	7	0.3	3	0.1	26	1
	1965*	2535	1109	43	[illegible]	7	918	35	221	9	24	1	3	0.1
Grand Totals		7633	3195	42	1158	15	2822	37	228	3	27	0.4	93	1

Aedes fitchii with 130 total larvae constitute 5% of the 1965 total and 2% of the Grand Total.

Appendix Table 4

WEEKLY COMPARISON OF MOSQUITO LARVA DENSITIES MEASURED IN NUMBER OF LARVAE PER DIP

Lake Front Gun, Fur and Reclamation Club

Station		1				2				6				7			
Weeks		1962	1963	1964	1965	1962	1963	1964	1965	1962	1963	1964	1965	1962	1963	1964	1965
Apr.	1	x	x	x	0.07	x	x	x	0.01	x	x	x	0.08	x	x	x	0
	2	x	x	x	0.56	x	x	x	0.37	x	x	x	0.14	x	x	x	0
	3	x	x	1.12	0.33	x	x	0	1.05	x	x	4.47	0.48	x	x	0.31	0.15
	4	x	x	0.24	0.80	x	x	0	0.69	x	x	0.02	0.01	x	x	0	0.20
	5	x	x	0	x	x	x	0	x	x	x	0	x	x	x	0.01	x
May	1	1	0.01	0	1.67	-	0.07	0	0.09	x	0.03	x	0	x	0.01	0.06	0.33
	2	1	0.03	0.04	3.25	-	0	0.02	x	-	0.11	0.81	0.01	x	0	x	x
	3	x	x	0.01	15.0	x	x	0	0.47	x	x	0.04	0.02	x	x	0.11	0.12
	4	0.5	0.25	0	0	-	0.03	0.34	0.04	x	0.06	0	0.01	x	0.06	0.03	0.02
	5	0.53	0.19	x	x	1.00	0.05	x	x	0.37	0	x	0.01	x	0	x	x
June	1	0.11	0.46	0	0	0.92	0.11	0.01	0.24	0.02	0	0	0.03	x	0.03	0	0.05
	2	0.28	0.02	0.03	0	0.69	0.09	0.04	0.31	0.26	0	0	0.15	0.05	0	0	0
	3	1.23	0.06	0.03	0.12	3.06	0.01	0.01	0.18	1.59	0.03	0	0.25	0.01	0.23	0	0.11
	4	3.03	0.59	0.73	5.41	5.69	0	0	0.32	0.06	0.09	0	0.32	0.16	2.94	0	0.05
July	1	2.24	0.48	0.23	5.48	2.16	0.56	0	0.02	1.33	-	0	0.18	0.11	-	0	0
	2	0	-	0.12	0.76	1.43	-	0.12	1.73	0	-	0	0.13	0.27	-	0	0.03
	3	0	0	0	2.56	0	-	0	0.08	0	-	0	0.55	0.83	0	0	0.08
	4	3.50	6.81	-	2.74	2.26	0.07	0	0	0.74	0.51	-	1.43	1.07	0.11	-	0
	5	1.42	1.19	2.58	1.06	0.92	0.04	0.01	1.86	1	0.01	-	1.71	0.51	0	0.40	0.53
Aug.	1	0.09	2.48	0.24	0.70	0.03	0.28	0	1.83	0.70	0.08	0.60	1.25	0.03	0.03	0.06	0.15
	2	3.53	0.40	1.11	0.13	0.28	0.17	-	0	2.08	-	0.68	2.34	0.21	0	0.15	0.04
	3	0.11	0.20	-	0.55	0.92	0.13	-	1.40	0.46	0.07	0.72	0.30	2.27	0	0.11	5.34
	4	0.27	0.15	-	1.13	0.24	0.19	-	0.55	4.14	-	0.80	0.16	0.54	0	0.04	0.65
Sept.	1	0.60	0.62	-	0.92	0.08	0.10	-	0	0.12	-	0.08	1.39	0.43	-	-	2.03
	2	1.05	0.42	-	0	0.09	0.24	-	0	0.14	1.53	-	0.57	0.29	0.30	-	0.02
	3	0.45	0.86	-	0	0.03	0.17	-	0	0.87	0.73	-	0.81	0.01	0.07	-	0
	4	0.10	0.45	0.03	0	0.01	0.05	0.08	0	0.75	0.41	0	0	0	0.05	0	0
Oct.	1	x	x	0.20	x	x	x	0.10	x	x	x	0	x	x	x	0	x
	2	x	x	0.10	x	x	x	0.05	x	x	x	0	x	x	x	0	x
Overall Ave/dip		1.16	0.63	0.30	1.31	1.10	0.14	0.02	0.49	0.82	0.62	0.10	0.52	0.26	0.27	0.42	0.21

(x)=no sample taken (-)=area found dry (0)=sample taken but no larvae found

Appendix Table 4 (continued)

WEEKLY COMPARISON OF MOSQUITO LARVA DENSITIES MEASURED IN NUMBER OF LARVAE PER DIP

Lake Front Gun, Fur and Reclamation Club (continued)

Station		8				9				10			
Weeks		1962	1963	1964	1965	1962	1963	1964	1965	1962	1963	1964	1965
Apr.	1	x	x	x	0	x	x	x	0	x	x	x	0
	2	x	x	x	0	x	x	x	0	x	x	x	0
	3	x	x	0.31	0.01	x	x	0	0.04	x	x	0	0.03
	4	x	x	0	0	x	x	0	0	x	x	0	0.03
	5	x	x	0.01	x	x	x	0.02	x	x	x	0	x
May	1	x	0.01	0.06	0.01	x	0.13	0.04	0.28	x	0.30	0	0
	2	x	0	x	x	x	0.05	0.03	x	x	0.50	0.13	x
	3	x	x	0.11	0	x	x	0	0.04	x	x	0	0
	4	x	0.66	0.03	0.01	x	0.18	0.10	0.04	x	0.04	0.03	0
	5	x	0	x	x	0.43	0.10	x	x	x	0.40	x	x
June	1	x	0.03	0	0	0.32	0.24	0.10	0	0.16	0.40	0.05	0.13
	2	0.05	0	0	0.16	0.41	0.66	0.02	0.18	0.52	0.28	0.10	0
	3	0.01	0.23	0	0	0.32	0.18	0	0.20	1.62	0.30	0	0.13
	4	0.16	2.94	0	0.15	0.30	1.24	0.16	0.20	0.82	-	0.08	0.03
July	1	0.11	-	0	0	0.75	-	0.04	0.08	2.85	0.03	0	0.20
	2	0.27	-	0	1.53	1.36	-	0	0.48	2.15	-	0.04	1.63
	3	0.83	0	0	0.89	0.94	3.24	0	0.38	1.93	1.16	0	2.72
	4	1.07	0.11	-	1.19	0.82	0.16	-	0.38	1.17	0.04	-	0
	5	0.51	0	0.40	0	0.36	0.06	2.26	0.28	0.73	0.02	1.52	0.18
Aug.	1	0.03	0.03	0.06	0.66	0.74	0.84	0.38	0.54	0.37	0.38	0.13	0.58
	2	0.21	0	0.15	1.31	0.40	0.04	1.76	0.94	0.55	0.11	0.56	0
	3	2.27	0	0.11	1.12	0.76	0.24	0.84	1.22	0.37	0.04	1.18	0.25
	4	0.54	0	0.04	0.86	0.28	0.54	0.60	0.32	0.03	0.14	0.42	0.25
Sept.	1	0.43	-	-	1.28	0.52	0.52	0.52	0.13	0.23	0.32	0.20	0.40
	2	0.29	0.30	-	1.22	0.20	0.28	-	0.76	0.03	0.14	0.04	0
	3	0.01	0.07	-	1.31	0.02	0.44	-	0.84	0	0.26	0	0
	4	0	0.05	0	1.08	0.02	0.40	0	0.42	0.37	0.14	0	0
Oct.	1	x	x	0	x	x	x	0.04	x	x	x	0.03	x
	2	x	x	0	x	x	x	0	x	x	x	0	x
Overall Ave/dip		0.40	0.11	0.07	0.54	0.49	0.49	0.29	0.34	0.77	0.27	0.02	0.33

(x)=no samples taken (-)=area found dry (0)=sample taken but no larvae found

Appendix Table 4 (continued)

WEEKLY COMPARISON OF MOSQUITO LARVA DENSITIES MEASURED IN NUMBER OF LARVAE PER DIP

Farmington Bay Waterfowl Management Area

Station		2				3				5				6			
Weeks		1962	1963	1964	1965	1962	1963	1964	1965	1962	1963	1964	1965	1962	1963	1964	1965
Apr.	1	x	x	x	0	x	x	x	x	x	x	x	x	x	x	x	0
	2	x	x	x	0	x	x	x	x	x	x	x	x	x	x	x	0
	3	x	x	0.3	0	x	x	0.17	x	x	x	0.02	x	x	x	0	0
	4	x	x	0	0	x	x	0.56	x	x	x	0.10	x	x	x	0	0
	5	x	x	0.13	x	x	x	1.20	x	x	x	0.22	x	x	x	0	x
May	1	x	0	0	x	x	0.08	0.14	x	x	0.40	0.23	x	x	0	0	x
	2	x	0	0.02	0	x	0.11	0.10	x	x	0.76	0.23	x	x	0.12	0	0
	3	x	0	0	0	x	0.63	0.05	x	x	0.40	0.29	x	x	0.01	0	0
	4	x	0	0	0	x	0.10	0.06	x	0.22	0.06	0.27	x	0.03	0.03	0	0
	5	0.02	0	x	x	0.28	0.12	x	x	0.48	0.05	x	x	0.96	0.77	x	x
June	1	0.26	0.3	0	0	3.43	0.40	0.80	x	0.31	2.43	0.16	x	8.24	0.32	0	0
	2	4.50	0	0	0	4.34	0	0.14	x	0.73	2.30	0.02	x	4.70	3.60	0.01	0
	3	0.30	0	0	0	10.90	0.40	0.06	x	2	0.12	0	x	2.72	12.21	0.01	0
	4	0.06	0	0	0	10.17	1.36	0	x	0.10	0	0.45	x	2.97	0.05	0.01	0
July	1	0	-	0	0	2	0	0	x	0.90	0	0.36	x	0.76	-	0.02	0
	2	0	-	0	-	0.30	0	0.96	x	0.60	0.02	0.60	x	1.27	-	0	0.24
	3	1.23	-	-	-	12.15	3.50	0.83	x	3.50	0.10	1.19	x	4.06	0.32	0.08	0
	4	1.08	-	-	-	3.45	10.10	1.34	x	0.32	0.13	0.80	x	0	8.66	0	0
	5	1.44	-	-	0.34	25.6	11.40	1.62	x	1.12	0.40	0.51	x	0	1.80	0	0.01
Aug.	1	0.36	-	-	0.18	16.8	0	2.75	x	0	0	0.12	x	0	3.10	0.03	0
	2	0.47	-	-	0	1.4	-	0.84	x	0.40	-	0.22	x	0	1.08	0	0
	3	0.17	-	-	0	5.60	-	0.68	x	0	-	0.92	x	0.13	0.22	0	0
	4	0.05	-	-	0	0.60	0	0.08	x	0.27	1.70	2.24	x	22.8	0.32	0	0.01
Sept.	1	0.03	-	-	0.05	0	30.25	0.17	x	0.13	1.30	0.25	x	15.33	0.52	0	0
	2	0.02	-	-	0	0	25.0	0.06	x	0.50	0.80	0.01	x	.22	0.68	0	0.01
	3	0	0	0.25	0	0	1.69	0.29	x	1.03	0.25	0.17	x	4.54	0	0.10	0
	4	x	x	-	0	x	0.29	0.06	x	x	0.14	0	x	x	0	0.02	0
Oct.	1	x	x	-	x	x	x	-	x	x	x	-	x	x	x	-	x
	2	x	x	-	x	x	x	0.04	x	x	x	0.02	x	x	x	0.05	x
Overall Ave/dip		0.54	0.04	0.02	0.03	4.85	3.93	0.44		0.70	0.63	0.37		3.81	1.43	0.01	0.006

(x)=no sample taken (-)=area found dry (0)=sample taken but no larvae found

Appendix Table 4 (continued)

WEEKLY COMPARISON OF MOSQUITO LARVA DENSITIES MEASURED IN NUMBER OF LARVAE PER DIP

Farmington Bay Waterfowl Management Area (continued)

Station		7				8				10				14			
Weeks		1962	1963	1964	1965	1962	1963	1964	1965	1962	1963	1964	1965	1962	1963	1964	1965
Apr.	1	x	x	x	0	x	x	x	0	x	x	x	0	x	x	x	0
	2	x	x	x	0	x	x	x	0	x	x	x	0	x	x	x	0
	3	x	x	0	0	x	x	0.31	0	x	x	0.10	0	x	x	0	0
	4	x	x	0.11	0	x	x	0.16	0	x	x	0.08	0.02	x	x	0	0
	5	x	x	0.26	x	x	x	0.53	x	x	x	0.09	x	x	x	0	x
May	1	x	0.01	0.21	x	x	0.12	0	x	x	0.01	0.04	x	x	0	0.03	x
	2	x	0.16	0.75	0	x	0.12	0	0	x	0.02	0.33	1.04	x	0	0	0
	3	x	0.30	0.19	0	x	0.16	0.19	0	x	0.03	0	0	x	0	0	0
	4	0.58	0.20	0.01	0	x	0.12	0.39	0	x	0.11	0.05	0.02	x	0	0.13	.01
	5	2.29	0.11	x	x	0.41	0.37	x	x	0.31	0.12	x	x	x	0.04	x	x
June	1	0.11	0	0.04	0	3.92	0.89	0	.01	0.21	0.03	0.02	0.01	x	0.18	0.01	0
	2	2.06	0.55	0.06	0	2.50	2.56	0	0	0.43	0.01	0.01	0.12	x	0.03	0	0
	3	0.31	0.33	0	0.03	2.36	5.88	0.85	0.02	0.75	0.44	0	0.29	x	0.24	0	0
	4	0.07	0.26	0.75	0	6.56	6.27	0	0.11	0.71	0.05	0.50	0.24	2.20	1.24	0	0
July	1	0	0.08	0.11	x	4.98	-	2.11	0	1.23	-	1.17	1.66	1.60	0.39	0	0
	2	0	0.06	0.02	0.09	0.52	-	2.95	-	0.44	-	0.91	0.62	5.88	0.30	0	0.16
	3	0	0	0.62	0	0.80	-	1.59	-	1.31	-	0.73	3.33	0.84	0.10	0.87	0
	4	0	-	0.09	0	0.60	-	-	-	0.16	-	0.08	0	1.30	0.04	0.88	0.26
	5	0	0	0	3.72	0.80	-	0	-	1.04	-	0.04	0.69	2.10	0.02	0.74	0.13
Aug.	1	0	0	0	3.13	3.33	25.0	-	-	0	0	0.05	0.28	1.45	0	0.14	0.02
	2	0	0	-	0.92	0	11.41	-	-	0.04	8.82	0.02	0.85	0.65	0.42	0	0
	3	0	-	1.21	0.66	0	1.23	-	-	0.06	0.85	0.01	1.36	3.30	0	0	0.13
	4	0.47	-	0.14	0.77	0	9.0	-	6.68	0	0.68	0.18	0.87	0.60	0	0	0
Sept.	1	0.15	-	0	0.83	0	4.27	-	8.73	0.07	0	0	0.16	1.45	0.16	0	0
	2	0.03	-	1.24	0	0	7.50	-	0	0.04	0.08	1.56	0.14	1.10	0	0	0
	3	0	0	0.20	0.01	0	6.54	-	0.2	0.07	0.20	0.01	0.01	0.67	0.02	0	0
	4	x	0	0.08	0	x	0.26	0	-	x	0.31	0.04	0.44	x	x	0	0.01
Oct.	1	x	x	-	x	x	x	-	x	x	x	-	x	x	x	-	x
	2	x	x	0.30	x	x	x	1.85	x	x	x	0.08	x	x	x	0	x
Overall Ave/dip		0.91	0.20	0.03	0.46	2.48	2.09	0.50	1.31	0.48	0.25	0.22	0.48	1.76	0.19	0.12	0.05

(x)=no sample taken (-)=area found dry (0)=sample taken but no larvae found

Appendix Table 4 (continued)

WEEKLY COMPARISON OF MOSQUITO LARVA DENSITIES MEASURED IN NUMBER OF LARVAE PER DIP

Wheeler Machinery Company Test Area

Station	1			2A			2B			3		
Weeks	1963	1964	1965	1963	1964	1965	1963	1964	1965	1963	1964	1965
Apr. 1	x	-	-	x	0	0	x	0	5.50	x	0	0
2	x	-	-	x	0	0	x	0.21	0.20	x	0	0
3	x	-	-	x	-	0	x	0.06	0.20	x	0	0
4	x	-	-	x	-	0	x	0.05	0.32	x	0	0
5	x	-	x	x	0	x	x	0	x	x	0	x
May 1	-	-	-	0	0	0	0	0.03	0	0.23	0	0
2	-	-	-	0.02	0	0	0	0	0	0.54	0	0
3	-	-	-	0	0	0	0	0.08	0.73	0.44	0.24	0
4	-	-	-	0	0	0	0	0	0.09	0.41	0.04	0
5	-	x	-	0	x	0	0	x	0	0.08	x	0
June 1	-	-	-	0	-	-	0	0	-	0	0.89	0
2	-	-	-	0.05	-	-	0.10	4.63	-	0	0	0
3	-	-	-	2.55	-	-	0.03	1.27	-	0	0.58	0
4	-	-	-	-	-	-	0.04	-	-	0.03	0	0
July 1	-	-	-	-	-	-	-	-	-	0	0	0
2	-	-	-	-	-	-	-	-	-	0	0	0
3	-	-	-	-	-	-	-	-	-	0	1.62	-
4	-	-	-	-	-	-	-	-	-	0	0	-
5	-	-	-	-	-	-	-	-	-	0	0	-
Aug. 1	-	-	-	-	-	-	-	-	-	0	0	-
2	-	-	-	-	-	-	-	-	-	0	0	-
3	-	-	-	-	-	-	-	-	-	0	0	-
4	-	-	-	-	-	-	-	-	-	0	0	-
Sept. 1	-	-	-	-	-	-	-	-	-	0	0	0
2	-	-	-	-	-	-	-	-	-	0	0	0
3	-	-	-	-	-	-	-	-	-	0	0	0
4	-	-	-	-	-	-	-	-	-	0	-	0
Oct. 1	x	-	x	x	-	x	x	-	x	x	-	x
2	x	-	x	x	-	x	x	-	x	x	-	x
Overall Ave/dip	0	0	0	0.20	0	0	0.02	0.56	0.78	0.18	0.14	0

(x)=no sample taken (-)=area found dry (0)=sample taken but no larvae found

Appendix Table 4 (continued)

WEEKLY COMPARISON OF MOSQUITO LARVA DENSITIES MEASURED IN NUMBER OF LARVAE PER DIP

Wheeler Machinery Company Test Area (continued)

Station		4			5			6			7		
Weeks		1963	1964	1965	1963	1964	1965	1963	1964	1965	1963	1964	1965
Apr.	1	x	0	0	x	0	0	x	0	0	x	0	0
	2	x	0.04	0	x	-	0	x	0	0	x	0	0
	3	x	0.05	0	x	-	0	x	0	0	x	0	0
	4	x	0	0	x	-	0	x	0	0	x	0	0
	5	x	0	x	x	0	x	x	0	x	x	0	x
May	1	0	0	0	0	0	0	0.02	0	0	0	2.74	1.20
	2	0	0	0	0	0	0	0	0	0	0	0	0.03
	3	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0.13	0	0	0	0	0	0	0	0	0.89	0
	5	0	x	0	0	x	0	0	x	0	0	x	0
June	1	0	0.33	0	0	0	0	0	0.20	0	0.92	0.78	0
	2	0	0	0	0	0	0	0	0	0	0.04	0.09	0
	3	0	0	0.02	0	0	0	0.54	0	0.28	0	1.40	0
	4	0	1.2	0	0	0	0	0.02	0.50	0.78	0	2.50	0
July	1	0	0	0.05	0	0	0	0	0.20	0.10	12.5	-	0.28
	2	0	0	0.26	0	0	0	0	0.74	0.18	-	-	0
	3	0.03	0	0	0	0	0	0.40	0	0.27	-	-	0
	4	0.05	0.46	0.10	0	0	0	0.80	0.31	0.02	-	-	0
	5	0	0.40	0	0	0	0	0	0	0	-	-	0
Aug.	1	0.16	0	0	0	0	0	0	0	0.51	-	-	0
	2	0.10	0	0	0	0	0	0	0	0.75	-	-	0
	3	0	0	0	0	0	0	0	0	0	-	-	0
	4	-	0	0	0	0	0	0	0	0	-	-	5.56
Sept.	1	0	0	0	0	0	0	0	0	0	-	-	0
	2	0	0	0	0	0	0	0	0	0.8	-	-	0.64
	3	0.05	0	0	0	0	0	0	0	0	0.16	-	7
	4	-	0	0	0	0	0	-	0	0	4.33	-	7.20
Oct.	1	x	0	x	0	0	0	x	0	x	x	-	x
	2	x	0	x	0	0	0	x	0	x	x	-	x
Overall Ave/dip		0.01	0.10	0.02	0	0	0	0.09	0.04	0.16	1.78	0.63	1.58

(x)=no sample taken (-)=are found dry (0)=sample taken but no larvae found

Appendix Table 4 (continued)

WEEKLY COMPARISON OF A. [illegible] LARVA DENSITIES MEASURED IN NUMBER OF LARVAE PER DIP

Wheeler Machinery Company Test Area (continued)

Station	8			9			10			11		
Weeks	1963	1964	1965	1963	1964	1965	1963	1964	1965	1963	1964	1965
Apr. 1	x	0	0	x	0	0	x	0	0	x	0	0
2	x	0	0	x	0	0	x	0	0	x	0	0
3	x	0	0	x	0	0	x	0	0	x	0.04	0
4	x	0	0	x	0.08	0	x	0	0	x	0	0
5	x	0	x	x	0	x	x	0	x	x	0.88	x
May 1	0.17	0	0	0	0	0	0	0	0	0	1.06	0
2	0.14	0	0	0	0	0	0	0	0	0.02	0.52	0
3	0	0	0	0	0	0	0	0	0	0	0.55	0
4	0	0	0	0	0	0	0	0	0	0	2.60	0.60
5	0	x	0	0	x	0	0	0	0	0	x	0
June 1	0.02	0	0	0	0	0	0	0	0	0	0	0
2	1.30	0	0	0	0	0	0	0	0	0	5	0
3	0.20	0	0	0.24	0	0	0	0	0	0.70	0	0
4	1.86	0	0	0.16	0	0	0	0	0	0	0	0.10
July 1	1.05	0	0	0.04	0	0	0	0	0	-	0	0.38
2	-	0	0	0	0	0	0	0	0	-	0	0
3	-	4.40	0.05	0	0.30	0	0	0.01	0	-	0	1.61
4	8	0	0	0	0	0	0	0.03	0	-	0	2.75
5	-	0	0.01	-	0	0	0	0.67	0	-	0	4.68
Aug. 1	0	0.70	0	-	0.87	0	0	0	0	-	0	4.40
2	-	0.25	0	-	0	0	0	0	0	-	0.53	1.07
3	0	0	0	-	0.23	0	0	0	0	-	6.30	5.33
4	-	0	0	-	0	1.09	0	0	0	-	7.85	1.52
Sept. 1	-	2.60	0	-	0	0	0.88	0	0	-	2.7[illegible]	3.80
2	0	1	0	-	0	0	12	0	0	-	1.36	2.56
3	0.20	6.25	0	0	0	0	1.93	0	0	-	0.33	1.60
4	-	1.75	0	-	0	0	1.35	0.02	0	-	2.11	1.50
Oct. 1	x	2	x	x	0	x	x	0	x	x	1.72	x
2	x	0.08	x	x	0	x	x	0	x	x	1.21	x
Overall Ave/dip	0.56	0.53	0.01	0.03	0.43	0.03	0.96	0.03	0	0.08	1.65	1.26

(x)=no sample taken (-)=area found dry (0)=sample taken but no larvae found

Appendix Table 4 (continued)

WEEKLY COMPARISON OF MOSQUITO LARVA DENSITIES MEASURED IN NUMBER OF LARVAE PER DIP

Wheeler Machinery Company Test Area (continued)

Station		12			13			14			16		
Weeks		1963	1964	1965	1963	1964	1965	1953	1964	1965	1963	1964	1965
Apr.	1	x	0	0	x	0	0	x	0	0	x	0	0
	2	x	0.04	0	x	0	0	x	0	0	x	0	0
	3	x	0	0.67	x	0	0	x	0	0	x	0	0.93
	4	x	0.73	3.86	x	0	0	x	0	0	x	0	0.83
	5	x	0.67	4	x	0	x	x	0.40	x	x	0	1.67
May	1	0	0.80	4	0	0	0	0	0	0	0.48	0	0.07
	2	0	0.33	0.5	0	0	0	0	0	0	0	0	0
	3	0	0.56	2.50	0	0	0	0	0	0	0	0	0.31
	4	0	0.56	0	0	0	0	0	0	0	0	0	1.32
	5	0	x	0.10	0	0	0	0	x	0	0	x	0
June	1	0	0.07	0	0	0	0	-	0	0	13.33	0	0
	2	0	0.03	0	0	0	0	-	0	0	0	0	0
	3	4.81	0	0	0	0	0	-	0	0	0.7	0.30	0
	4	1.45	0	0	0	0	0	-	0	0	1.67	8	0
July	1	0.09	0	0	-	-	0	-	0	0	0.45	0.05	0.06
	2	0	0	0	-	-	0	-	0	0	0	0.27	0
	3	0	0	0	-	-	0	-	0	0	0.73	-	0
	4	0	-	0	-	-	0	-	0	0	0.9	-	0.31
	5	0	-	0	-	-	0	-	0	0	2.5	-	0
Aug.	1	-	-	0	-	-	0	-	0	0	0.5	-	0
	2	-	-	0	-	-	0	-	0	0	1.13	0	0
	3	-	-	0	-	-	0	-	0	0	0.45	0	0
	4	-	-	10	-	-	0	-	0	0	3.6	0	0
Sept.	1	-	-	0	-	-	0	-	0	0	2.75	-	0
	2	-	-	0	-	-	0	-	0	0	1.50	-	0
	3	0	-	0	0	0	0	0	0	0	1.42	-	0
	4	-	-	0	-	-	0	-	0	0	-	-	0
Oct.	1	x	-	x	x	0	x	x	0	x	x	-	x
	2	x	-	x	x	0	3	x	0	x	x	-	x
Overall Ave/dip		0.54	0.32	1.84	0	0	0	0	0.02	0	1.34	0.42	0.53

(x)=no sample taken (-)=area found dry (0)=sample taken but no larvae found

Appendix Table 5

LARVAL INDEX

Lake Front Gun, Fur and Reclamation Club

Station	1				2				6				7			
Weeks	1962	1963	1964	1965	1962	1963	1964	1965	1962	1963	1964	1965	1962	1963	1964	1965
Apr. 1	x	x	x	0.11	x	x	x	0.14	x	x	x	0.35	x	x	x	0
2	x	x	14.34	4.20	x	x	0	5	x	x	x	1.48	x	x	2.79	0
3	x	x	3.07	1.19	x	x	0	14.13	x	x	53.64	3.80	x	x	0	1.35
4	x	x	0	3	x	x	0	9.32	x	x	0.24	0.11	x	x	0.09	1.80
5	x	0.11	0	x	x	0.84	0	x	x	0.36	0	x	x	0.09	0.54	x
May 1	x	0.45	0.60	11.27	-	0	0.27	1.22	-	1.32	8.10	0	x	0	0	2.97
2	x	x	0.15	19.50	-	x	0	x	x	x	0.48	0.08	x	x	0.99	x
3	x	3.75	0	22.50	x	0.41	4.05	6.35	x	0.58	0	0.12	x	0.45	0.27	1.08
4	6.92	2.28	0	0	3	0.68	0	0.54	4.44	0	0	0.11	x	0	0	0.18
June 1	1.44	6.90	0	0	6.81	1.49	0.13	3.24	0.24	0	0	0.32	x	0.23	0	0.45
2	4.20	0.30	0.45	0	9.32	1.22	0.54	4.19	3.12	0	0	1.58	0.45	0	0	0
3	18.45	0.90	0.45	1.80	41.31	0.14	0.14	2.43	19.08	0.29	0	3	0.09	0	0	0.99
4	45.45	8.85	10.95	81.15	63.28	0	0	4.32	0.54	0.54	0	3.84	1.44	26.46	0	0.45
July 1	16.80	1.68	3.45	32.20	19.22	7.56	0	0.27	2.39	0	0	2.16	0.99	0	0	0
2	0	-	1.80	3.55	2.86	-	1.62	10.28	0	0	0	1.29	2.43	0	0	0.27
3	0	0	0	6.14	0	-	0	1.08	0	0	0	2.90	7.47	0	0	0.72
4	52.50	34.05	0	18.91	30.51	0.95	0	0	30.83	0	0	15.10	9.63	0.99	0	0
5	21.30	17.85	38.70	15.90	93.42	0.54	0.14	25.11	12	0	0	20.52	4.59	0	0	4.77
Aug. 1	1.35	37.20	3.60	10.50	0.36	3.78	0	24.71	3.40	0.13	6.36	15	0.27	0.27	0.54	1.35
2	42.36	0	16.95	1.95	3.36	2.30	0	0	13.72	-	7.21	28.08	1.39	0	1.35	0.30
3	1.65	0	0	8.25	11.04	1.76	0	11.90	4.42	0.03	7.63	0.79	20.43	0	0.99	0.48
4	4.07	2.25	0	16.95	2.03	2.57	0	7.43	49.68	0	8.48	1.92	4.86	0	0.36	5.85
Sept. 1	9	9.30	0	13.30	0.96	1.35	0	0	1.44	0	0.85	16.68	3.87	0	0	18.27
2	15.75	6.30	0	0	1.03	3.24	0	0	1.68	10.36	0	6.84	2.61	2.70	0	0.15
3	6.75	12.90	0	0	0.36	2.30	0	0	10.44	3.76	0	9.72	0.09	0.63	0	0
4	1.50	6.75	0.45	0	0.12	0.68	1.08	0	[illegible]	4.92	0	0	0	0.45	0	0
Oct. 1	x	x	3	x	x	x	1.35	x	x	x	0	x	x	x	0	x
2	x	x	1.50	x	x	x	0.63	x	x	x	0	x	x	x	0	x

Appendix **Table** 5(continued)

LARVAL INDEX

Lake Front Gun, Fur and Reclamation Club(continued)

Station	8				9				10			
Weeks	1962	1963	1964	1965	1962	1963	1964	1965	1962	1963	1964	1965
Apr. 1	x	x	x	0	x	x	x	0	x	x	x	0
2	x	x	4.65	0	x	x	0	0	x	x	0	0
3	x	x	0	0.15	x	x	0	0.30	x	x	0	0.18
4	x	x	0.15	0	x	x	0.15	0	x	x	0.12	0.18
5	x	0.15	0.90	x	x	1.35	0.30	x	x	1.80	0.24	x
May 1	x	0	0	0.15	x	0.38	0.23	2.10	x	3	0.18	0.18
2	x	x	0	x	x	x	0	x	x	x	0	x
3	x	9.90	1.65	0	x	1.35	0.75	0.30	x	0.24	0.60	0.18
4	x	0	0.45	0.15	1.94	0.75	0	0.30	x	2.40	0	0.18
June 1	x	0.45	0	0	2.40	1.80	0.75	0	0.48	2.40	0.60	0.78
2	0.75	0	0	1.20	3.08	4.95	0.15	1.35	1.56	1.68	0.12	0
3	0.15	3.45	0	0	2.40	1.35	0	1.50	9.72	1.80	0	0.78
4	2.40	7.64	0	2.25	2.25	9.30	1.20	1.50	4.92	0	0.96	0.18
July 1	1.65	0	0	0	5.63	0	0.30	0.60	17.10	0.18	0.24	1.20
2	4.05	0	0	22.95	10.20	0	0	3.60	12.90	0	0	9.78
3	12.45	0	0	13.35	7.05	24.30	0	2.85	11.58	6.96	0	16.32
4	16.05	0.73	0	17.85	6.15	1.20	0	2.85	7.02	0.24	0	0
5	7.65	0	6	0	2.70	0.45	16.95	2.10	4.38	0.12	13.56	1.08
Aug. 1	0.45	0.27	0.90	7.92	5.55	6.30	2.85	4.05	2.22	2.28	2.28	3.48
2	3.15	0	2.25	27.15	3	0.14	13.20	7.05	3.30	0.57	10.56	0
3	34.05	0	1.65	16.80	5.70	1.80	6.30	9.15	2.22	0.24	5.04	1.50
4	8.10	0	0.60	12.90	2.10	3.02	4.50	6.15	0.18	0.84	3.60	1.50
Sept.1	6.45	0	0	15.36	3.90	3.90	3.90	1.35	1.38	1.92	3.12	1.20
2	4.35	1.35	0	18.30	1.50	2.10	0	5.70	0.18	0.84	0	0
3	0.15	0.56	0	19.65	0.15	3.30	0	6.30	0	1.56	0	0
4	0	0.33	0	12.96	0.15	3	0	2.52	2.22	0.84	0	0
Oct. 1	x	x	0	x	x	x	0.30	x	x	x	0.24	x
2	x	x	0	x	x	x	0	x	x	x	0	x

Appendix Table 5 (continued)

LARVAL INDEX

Farmington Bay Waterfowl Management Area

Station	2				6				7				14			
Weeks	1962	1963	1964	1965	1962	1963	1964	1965	1962	1963	1964	1965	1962	1963	1964	1965
Apr. 1	x	x	x	0	x	x	x	0	x	x	x	0	x	x	x	0
2	x	x	1.80	0	x	x	0	0	x	x	0	0	x	x	0	0
3	x	x	0	0	x	x	0	0	x	x	1.65	0	x	x	0	0
4	x	x	0.78	x	x	x	0	0	x	x	3.90	0	x	x	0	0
5	x	0	0	x	x	0	0	x	x	0.11	3.15	x	x	0	0.36	x
May 1	x	0	0.12	x	x	1.43	0	x	x	2.40	11.25	x	x	0	0	x
2	x	0	0	0	x	0.13	0	0	x	4.50	2.85	0	x	0	0	0
3	x	0	0	0	0	0.41	0	0	0	3	0.12	0	x	0	1.38	0
4	0.12	0	0	0	12.96	10.40	0	0	17.18	1.65	0	0	x	0.48	0	0.12
June 1	1.56	1.80	0	0	111.24	4.32	0	0	1.65	0	0.60	0	x	2.16	0.12	0
2	27	0	0	0	16.92	48.60	0.14	0	30.90	8.25	0.90	0	x	0.96	0	0
3	1.35	0	0	0	20.13	79.37	0.13	0	3.41	4.95	0	0.34	x	2.88	0	0
4	0.31	0	0	0	15.44	0.15	0.12	0	0.69	3.90	10.05	0	11.60	14.88	0	0
July 1	0	0	0	0	2.74	0	0.24	0	0	0.84	1.32	x	6.40	4.68	0	0
2	0	0	0	-	5.72	0	0	1.10	0	0.59	0.28	0.43	18.82	3.60	0	1.92
3	6.40	0	0	-	8.93	1.22	0.95	0	0	0	8.37	0	2.69	1.20	10.44	0
4	4	0	0	-	0	19.92	0	0	0	0	0.48	0	5.20	0.48	10.56	3.12
5	5.33	0	0	1.16	0	8.10	0	0.14	0	0	0	41.29	5.46	0.24	8.53	1.56
Aug. 1	1.33	0	0	1.08	0	27.90	0.18	0	0	0	0	31.16	3.77	0	1.58	0.24
2	2.12	0	0	0	0	14.58	0	0	0	0	0	9.66	1.69	5.04	0	0
3	0.77	0	0	0	0.59	1.80	0	0	0	0	11.13	9.90	0.58	0	0	1.56
4	0.26	0	0	0	34.20	1.50	0	0.14	1.08	0	1.05	9.24	1.92	0	0	0
Sept. 1	0.14	0	0	0.17	82.49	2.60	0	0	0.45	0	0	5.23	3.77	0	0	0
2	0.10	0	0	0	43.57	1.84	0	0.14	0.14	0	8.43	0	4.40	0	0	0
3	0	0	0	0	24.06	0	1.19	0	0	0	1.50	0.12	2.68	0.18	0	0
4	x	x	0	0	x	x	0.22	0	x	0	0.72	0	x	x	0	0.12
Oct. 1	x	x	0	x	x	x	0	x	x	x	0	x	x	x	0	x
2	x	x	0	x	x	x	0.02	x	x	x	2.25	x	x	x	0	x

Appendix Table 5 (continued)

LARVAL INDEX

Farmington Bay Waterfowl Management Area (continued)

Station	8				10			
Weeks	1962	1963	1964	1965	1962	1963	1964	1965
Apr. 1	x	x	x	0	x	x	x	0
2	x	x	4.65	0	x	x	1.50	0
3	x	x	2.40	0	x	x	1.20	0
4	x	x	7.95	0	x	x	1.35	0.27
5	x	1.80	0	x	x	0.10	0.60	x
May 1	x	1.80	0	x	x	0.30	4.95	x
2	x	2.40	2.85	0	x	0.45	0	8.63
3	x	1.80	4.10	0	x	1.65	0.75	0
4	3.08	5.55	0	0	4.65	1.80	0	0.30
June 1	29.40	13.35	0	0.14	3.15	0.45	0.30	0.15
2	18.75	38.40	0	0	6.45	0.15	0.15	1.80
3	35.40	38.20	12.75	0.15	11.25	6.25	0	4.35
4	24.93	10.66	0	0.32	10.65	0.15	7.50	3.60
July 1	26.39	0	31.65	0	13.45	0	11.47	24.90
2	3.12	0	44.25	-	6.60	0	9.19	5.70
3	3.04	0	17.97	-	19.65	0	10.95	16.65
4	1.38	0	0	-	1.81	0	1.20	0
5	1.20	0	0	-	3.95	0	0.31	10.35
Aug. 1	5.99	37.50	0	-	0	0	0.15	4.20
2	0	54.77	0	-	0.60	14.99	0.17	12.75
3	0	12.05	0	-	0.90	2.55	0.09	20.40
4	0	21.60	0	100.20	0	10.20	1.76	13.05
Sept. 1	0	19.22	0	104.76	1.05	0	0	2.40
2	0	9	0	0	0.60	1.20	18.72	2.10
3	0	13.08	0	0.18	1.05	3	0.12	0.15
4	0	x	0	-	x	3.72	0.60	6.60
Oct. 1	x	x	0	x	x	x	0	x
2	x	x	5.55	x	x	x	0.96	x

Appendix Table 5 (continued)

LARVAL INDEX

Wheeler Machinery Test Area

Station	2A			2B			3			4			5		
Weeks	1963	1964	1965	1963	1964	1965	1963	1964	1965	1963	1964	1965	1963	1964	1965
Apr. 1	x	0	0	x	0	17.6	x	0	0	x	0	0	x	0	0
2	x	0	0	x	0.8	0.8	x	0	0	x	0.1	0	x	0	0
3	x	0	0	x	0.2	0.8	x	0	0	x	0.2	0	x	0	0
4	0	0	0	0	0.2	1.3	1.2	0	0	0	0	0	0	0	0
5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
May 1	0	0	0	0	0.1	0	2.7	0	0	0	0	0	0	0	0
2	0.1	0	0	0	0	0	2.2	0	0	0	0	0	0	0	0
3	0	0	0	0	0.3	2.6	2.1	1	0	0	0	0	0	0	0
4	0	0	0	0	0	0.3	0.4	0.2	0	0	0.8	0	0	0	0
June 1	0	0	0	0	0	0	0	2.8	0	0	1.5	0	0	0	0
2	3	0	0	0.4	13.5	0	0	0	0	0	0	0	0	0	0
3	7	0	0	0.1	5.1	0	0	2.9	0	0	0	0.1	0	0	0
4	0	0	0	0.2	0	0	0.2	0	0	0	3.6	0	0	0	0
July 1	0	0	0	0	0	0	0	0	0	0	0	0.2	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	1.1	0	0	0
3	0	0	0	0	0	0	0	8.1	0	0.2	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0.3	2.8	0.6	0	0	0
5	0	0	0	0	0	0	0	0	0	0	2.4	0	0	0	0
Aug. 1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0.6	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sept. 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0.3	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oct. 1	x	0	x	x	0	x	x	0	x	x	0	x	x	0	x
2	x	0	x	x	0	x	x	0	x	x	0	x	x	0	x

Appendix Table 5 (continued)

LARVAL INDEX

Wheeler Machinery Test Area(continued)

Station	6			7			8			9			10		
Weeks	1963	1964	1965	1963	1964	1965	1963	1964	1965	1963	1964	1965	1963	1964	1965
Apr. 1	x	0	0	x	0	0	0	0	0	0	0	0	x	0	0
2	x	0	0	x	0	0	0	0	0	0	0	0	x	0	0
3	x	0	0	x	0	0	0	0	0	0	18	0	x	0	0
4	0	0	0	0	0	0	0	0	0	0	0.30	0	x	0	0
5	x	x	x	x	x	x	1.02	0	0	0	4.50	0	0	0	0
May 1	0.1	0	0	0	10.9	3.8	0.84	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	3.6	0	0	0	0	0	0	0	0	0	0
June 1	0	1.2	0	1.7	3.12	0	0.12	0	0	0	0	0	0	0	0
2	0	0	0	0.2	0.36	0	7.80	0	0	0	0	0	0	0	0
3	3.2	0	1.7	0	5.6	0	1.20	0	0	1.44	0	0	0	0	0
4	0.1	3	4.7	0	10	0	11.16	0	0	0.96	0	0	0	0	0
July 1	0	1.2	0.6	40	0	1.1	3.57	0	0	0.14	0	0	0	0	0
2	0	4.4	1.1	0	0	0	0	0	0	0	0	0	0	0	0
3	2.4	0	1.6	0	0	0	0	11.40	0.30	0	0.90	0	0	0.08	0
4	4.8	1.9	0.12	0	0	0	23.20	0	0	0	0	0	0	0.23	0
5	0	0	0	0	0	0	0	0	0.06	0	0	0	0	4.56	0
Aug. 1	0	0	3.1	0	0	0	0	2.52	0	0.01	2.18	0	0	0	0
2	0	0	4.5	0	0	0	0	0.88	0	0	11.50	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0.74	0	0	0	0
4	0	0	0	0	0	22.2	0	0	0	0	0	3.27	0	0	0
Sept.1	0	0	0	0	0	0	0	9.36	0	0	0	0	6.60	0	0
2	0	0	4.8	0	0	2.6	0	3.50	0	0	0	0	90	0	0
3	0	0	0	0.6	0	12.6	0.52	17.50	0	0	0	0	14.48	0	0
4	0	0	0	4.3	0	17.3	0	7	0	0	0	0	10.13	0.15	0
Oct. 1	x	0	x	x	0	x	x	8.60	x	x	0	x	x	0	x
2	x	0	x	x	0	x	x	0.34	x	x	0	x	x	0	x

Appendix Table 5 (continued)

LARVAL INDEX

Wheeler Machinery Test Area (continued)

Station	11			12			13			14			16		
Weeks	1963	1964	1965	1963	1964	1965	1963	1964	1965	1963	1964	1965	1963	1964	1965
Apr. 1	x	0	0	x	0	0	0	0	x	x	0	0	x	0	0
2	x	0	0	x	0.14	3.35	0	0	x	x	0	0	x	0	2.8
3	x	0.16	0	x	0	18.14	0	0	x	x	0	0	x	0	2.5
4	x	0	0	x	2.49	20	0	0	x	x	0	0	x	0	5
5	x	3.26	0	x	2.61	18.80	0	x	x	x	1.60	0	x	0	0.2
May 1	0.09	4.77	0	0	2.88	1.75	0	0	0	0	0	0	0.24	0	0
2	0	1.66	0	0	0.99	12.50	0	0	0	0	0	0	0	0	0.9
3	0	2.48	2.46	0	2.02	0	0	0	0	0	0	0	0	0	1.1
4	0	0.26	0	0	2.02	0.50	0	0	0	0	0	0	0	0	0
June 1	0	0	0	0	0.30	0	0	0	0	-	0	0	22.66	0	0
2	0	15	0	0	0.15	0	0	0	0	-	0	0	4.20	0	0
3	2.10	0	0	17.80	0	0	0	0	0	-	0	0	1.6	0.5	0
4	0	0	0.45	4.21	3.40	0	0	0	0	-	0	0	2.5	1.8	0
July 1	-	0	1.22	0.27	0	0	-	0	0	-	0	0	0.7	0.2	1.8
2	-	0	0	0	0	0	-	0	0	-	0	0	0	0.6	0
3	-	0	7.25	0	0	0	-	0	0	-	0	0	1.1	-	0
4	-	0	12.38	0	-	0	-	0	0	-	0	0	1.4	-	0.9
5	-	0	21.06	0	-	0	-	0	0	-	0	0	3.8	-	0
Aug. 1	-	0	13.20	-	-	0	-	0	0	-	0	0	0.8	-	0
2	-	2.39	4.82	-	-	0	-	0	0	-	0	0	2.6	0	0
3	-	25.20	12.26	-	-	0	-	0	0	-	0	0	1.4	0	0
4	-	17.27	6.84	-	-	17	-	0	0	-	0	0	5.4	0	0
Sept.1	-	8.86	14.06	-	-	0	-	0	0	-	0	0	8.3	-	0
2	-	5.85	9.47	-	-	0	-	0	0	-	0	0	2.7	-	0
3	-	0.89	4.80	0	-	0	0	0	0	0	0	0	4.3	-	0
4	-	5.70	6.75	-	-	0	-	0	0	-	0	0	-	-	0
Oct. 1	x	4.64	x	x	x	x	0	x	x	x	0	x	x	-	x
2	x	4.96	x	x	x	x	0	x	x	x	0	x	x	-	x

Appendix Table 5 continued)

TOTAL SEASONAL LARVAL INDEX

Lake Front Gun, Fur and Reclamation Club

Sampling Station	1962	1963	1964	1965
1	14.7	7.7	3.8	12.3
2	11.2	1.9	0.2	6.5
6	8.3	3.5	0.92	5.4
7	2.3	1.6	3.2	1.8
8	6	0.8	0.8	7.7
9	2.7	3.1	1.9	2.5
10	4.2	1.5	0.1	1.9

Farmington Bay Waterfowl Management Area

Sampling Station	1962	1963	1964	1965
2	2.6	0.1	0.05	0.1
6	16.8	10.3	0.1	0.07
7	3.9	1.6	0.3	4.7
8	8.4	14.6	4.1	8.6
10	6.7	2.2	2.7	5.8
14	17.8	2	1.3	0.5

Wheeler Machinery Company Test Area

Sampling Station	1962	1963	1964	1965
1	-	0	0	0
2A	-	0.3	0	0
2B	-	0.04	1	0.9
3	-	0.7	0.04	0
4	-	0.06	0.5	0.1
5	-	0	0	0
6	-	0.5	0.2	0.9
7	-	2	1.1	1.6
8	-	1.8	2.2	0.06
9	-	0.07	0.1	0.1
10	-	5.6	0.1	0
11	-	0.1	4.8	5
12	-	1.1	0.6	3.5
13	-	0	0	0
14	-	0	0.08	0
16	-	2.5	0.6	1.5

*These figures were obtained by multiplying the average number of larvae per dip times the average acreage [redacted] for the season.

Appendix Table 6

COMPARISON OF AVERAGE WEEKLY LIGHT TRAP COLLECTIONS

Farmington Bay Wildlife Management Area

		June				July					August				September				Oct.		TOTALS
		1	2	3	4	1	2	3	4	5	1	2	3	4	1	2	3	4	1	2	
Aedes dorsalis	1962	11	10	3	-	11	31	6	37	37	60	11	19	5	18	118	7	53	17	36	490
	1963	5	6	109	-	12	16	2	15	15	16	34	16	28	5	69	14	38	-	-	400
	1964	33	5	32	-	-	11	21	-	13	21	14	7	6	30	15	8	3	3	1	223
	1965	5	20	14	6	7	35	25	27	3	27	46	37	31	4	47	20	-	-	-	354
Culiseta inornata	1962	47	82	6	-	73	45	10	61	20	46	11	20	32	22	16	16	46	-	-	595
	1963	20	50	40	-	5	4	3	20	6	3	10	1	9	2	4	7	40	-	-	224
	1964	3	2	6	-	-	3	12	-	22	48	32	18	1	2	2	6	1	-	-	63
	1965	2	4	12	4	4	3	4	8	6	0	1	6	16	3	11	2	-	-	-	84
Culex tarsalis	1962	25	38	4	-	21	48	141	468	368	443	180	101	152	210	125	126	207	-	-	2943
	1963	8	35	26	-	6	16	12	30	12	8	21	4	30	1	14	13	123	-	-	359
	1964	5	39	33	-	-	27	6	-	21	34	19	9	14	13	6	3	6	-	-	250
	1965	4	10	1	12	14	23	33	72	0	415	109	159	199	4	17	56	-	-	-	1128
Culex erythrothorax	1962	0	0	0	-	0	0	5	12	13	10	22	1	3	23	26	26	37	-	-	216
	1963	1	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	1	-	-	2
	1964	1	0	0	-	-	1	2	-	1	1	1	10	20	7	3	3	4	-	-	54
	1965	0	0	0	0	0	3	23	89	164	455	120	138	88	4	59	44	-	-	-	1187
Culex pipiens	1962	1	0	0	-	0	4	0	4	2	0	3	0	1	1	1	1	0	-	-	18
	1963	0	0	0	-	0	0	0	0	0	0	0	0	3	3	0	0	0	-	-	6
	1964	1	0	2	-	-	1	2	-	1	7	2	0	0	0	0	0	0	-	-	16
	1965	0	0	0	0	0	0	0	1	0	0	2	0	37	1	1	0	-	-	-	42
Aedes nigromaculis	1963	0	0	0	-	0	0	0	0	0	0	0	0	0	1	0	0	0	-	-	1
	1964	0	0	0	-	-	0	0	-	0	2	0	0	0	0	0	0	0	-	-	2
Aedes vexans	1965	0	0	0	0	0	0	0	0	262	0	0	1	0	0	0	0	-	-	-	263
Anopheles freeborni	1963	0	0	0	-	1	0	0	0	0	0	0	0	0	0	0	0	0	-	-	1
	1965	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0			-	5
TOTALS	1962	84	130	13	-	105	128	162	582	440	559	227	141	193	274	266	175	343	312	118	4272
	1963	34	91	175	-	24	36	17	65	33	27	65	21	70	9	87	34	202	-	-	990
	1964	43	46	73	-	-	42	41	-	57	113	68	44	41	52	26	20	14	17	5	758
	1965	11	34	27	22	30	64	85	197	435	897	278	341	371	14	135	122	-	-	-	3063

*In those years which have been deleted from the chart, samples were taken but no mosquitoes found

Appendix Table 6 (continued)

COMPARISON OF AVERAGE WEEKLY LIGHT TRAP COLLECTIONS

South Davis Sewage Treatment Plant

		June				July					August				September				Oct.*		TOTALS
		1	2	3	4	1	2	3	4	5	1	2	3	4	1	2	3	4	1	2	
Aedes dorsalis	1962	0	5	2	3	2	14	2	3	55	5	116	17	1	26	9	51	26	-	-	367
	1963	3	7	112	12	10	30	6	27	85	129	96	2	43	102	43	37	-	307	1	1114
	1964	1	14	20	8	30	3	[illegible]	18	24	65	100	9	5	5	3	49	13	15	16	436
	1965	-	-	-	36	72	56	3	4	0	2	4	3	0	-	-	-	-	-	-	181
Culiseta inornata	1962	7	47	62	50	57	135	27	132	62	39	103	42	5	70	8	51	16	-	-	923
	1963	70	129	305	89	40	203	27	176	75	155	39	2	63	27	11	9	-	19	-	2102
	1964	2	10	43	33	43	51	409	40	173	130	208	19	20	9	20	15	0	1	1	1233
	1965	-	-	-	123	54	65	1	3	1	21	10	2	0	-	-	-	-	-	-	280
Culex tarsalis	1962	2	4	4	7	14	32	17	39	239	14	62	46	1	20	1	17	3	-	-	617
	1963	7	27	26	7	27	95	16	73	90	62	70	2	90	30	21	8	-	27	-	678
	1964	1	10	50	30	32	14	131	38	177	169	197	25	12	5	4	7	0	3	1	907
	1965	-	-	-	17	51	63	4	13	12	0	12	11	3	-	-	-	-	-	-	191
Culex erythrothorax	1962	0	0	0	0	0	0	0	2	6	0	3	4	0	3	3	6	1	-	-	28
	1963	0	0	3	0	0	0	0	1	0	0	0	0	0	0	1	1	-	5	-	11
	1964	0	0	0	0	1	0	2	2	14	24	8	12	10	2	15	4	1	0	1	96
	1965	-	-	-	2	6	3	0	1	5	2	3	3	0	-	-	-	-	-	-	25
Culex pipiens	1962	0	0	0	0	0	3	1	0	4	1	3	0	0	1	1	5	2	-	-	21
	1963	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	-	0	-	2
	1964	0	0	0	0	0	0	0	1	6	8	8	2	2	0	0	0	0	0	0	27
Aedes nigromaculis	1963	0	0	1	0	0	0	0	0	0	0	0	0	0	3	1	3	-	0	-	8
	1964	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	2
Anopheles freeborni	1965	-	-	-	0	0	0	0	0	0	6	4	0	0	-	-	-	-	-	-	10
TOTALS	1962	9	56	68	70	73	234	47	176	426	59	287	109	7	120	22	160	38	-	-	1961
	1963	60	167	478	96	73	336	46	257	250	346	255	6	196	[illegible]	78	59	-	358	-	3125
	1964	7	34	121	71	112	68	568	100	394	397	521	67	50	21	42	75	12	22	19	2701
	1965	-	-	-	178	183	167	8	26	18	32	33	19	3	-	-	-	-	-	-	687

*In those years which have been deleted from the chart, samples were taken but no mosquitoes found.

Appendix Table 7

COMPARISON OF AVERAGE WEEKLY COLLECTIONS OF BITING MOSQUITOES

Farmington Bay Waterfowl Management Area

		June				July					August				September				Oct.		TOTALS
		1	2	3	4	1	2	3	4	5	1	2	3	4	1	2	3	4	1	2	
Aedes dorsalis	1962	-	-	94	0	1	42	2	10	56	4	10	5	7	38	60	33	36	-	-	398
	1963	-	-	-	-	-	-	-	11	54	7	20	10	10	5	7	39	-	-	-	163
	1964	-	-	94	61	74	57	171	79	-	42	85	33	66	49	58	66	106	30	34	1105
	1965	-	-	-	-	486	345	-	-	-	7	5	7	2	-	-	-	-	-	-	852
Culiseta inornata	1962	-	-	24	0	2	28	1	3	8	16	5	0	2	1	0	0	0	-	-	90
	1963	-	-	-	-	-	-	-	32	52	9	4	1	9	13	1	1	-	-	-	122
	1964	-	-	4	19	62	27	27	9	1	26	12	4	0	5	4	1	0	0	0	196
	1965	-	-	-	-	5	11	-	-	-	14	0	5	2	-	-	-	-	-	-	37
Culex tarsalis	1962	-	-	6	0	0	14	14	6	12	2	24	6	5	6	4	0	0	-	-	99
	1963	-	-	-	-	-	-	-	2	4	1	1	0	1	0	0	0	-	-	-	9
	1964	-	-	32	10	17	20	19	16	-	72	44	10	8	10	13	0	0	0	0	271
	1965	-	-	-	-	48	120	-	-	-	15	1	4	3	-	-	-	-	-	-	191
Culex erythro-thorax	1962	-	-	4	0	0	0	0	1	1	0	0	0	0	22	51	20	20	-	-	119
	1963	-	-	-	-	-	-	-	1	1	0	0	0	1	0	0	0	-	-	-	3
	1964	-	-	0	1	2	0	1	0	-	86	9	7	4	1	3	2	1	1	2	120
	1965	-	-	-	-	37	52	-	-	-	95	173	71	93	-	-	-	-	-	-	521
Culex pipiens	1962	-	-	0	0	0	0	0	0	1	0	0	0	0	0	2	1	0	-	-	4
	1964	-	-	0	1	0	0	0	0	-	0	2	0	0	0	0	0	0	0	0	3
Aedes nigro-maculis	1963	-	-	-	-	-	-	-	0	0	0	0	0	0	0	1	0	-	-	-	1
Aedes vexans	1965	-	-	-	-	0	0	-	-	-	0	0	0	1	-	-	-	-	-	-	1
TOTALS	1962	-	-	128	0	3	84	17	20	78	22	39	11	14	67	117	54	56	-	-	710
	1963	-	-	-	-	-	-	-	46	111	17	25	11	21	18	9	40	-	-	-	298
	1964	-	-	130	92	155	100	218	104	-	226	152	54	78	65	78	69	107	31	36	1695
	1965	-	-	-	-	576	528	-	-	-	131	179	87	101	-	-	-	-	-	-	1602

*In those years which have been deleted from the chart, samples were taken but no mosquitoes found

Appendix Table 7 (continued)

COMPARISON OF AVERAGE WEEKLY COLLECTIONS OF BITING MOSQUITOES

South Davis Sewage Treatment Plant

		June				July					August				September				Oct.		TOTALS
		1	2	3	4	1	2	3	4	5	1	2	3	4	1	2	3	4	1	2	
Aedes dorsalis	1962	-	-	-	11	52	-	4	-	22	94	2	4	28	41	329	26	0	-	-	613
	1963	-	-	-	-	-	-	-	61	105	81	147	6	30	39	42	208	54	-	-	773
	1964	-	-	23	25	101	145	8	95	-	120	108	17	127	106	35	74	109	38	39	1170
	1965	-	-	-	-	92	79	-	-	-	-	-	-	-	-	-	-	-	-	-	171
Culiseta Inornata	1962	-	-	-	0	132	-	10	-	1	30	0	4	4	0	0	0	0	-	-	181
	1963	-	-	-	-	-	-	-	25	11	9	4	0	3	4	0	3	12	-	-	71
	1964	-	-	2	6	34	28	20	7	-	23	13	2	11	13	14	0	0	0	0	173
	1965	-	-	-	-	13	8	-	-	-	-	-	-	-	-	-	-	-	-	-	21
Culex tarsalis	1962	-	-	-	0	5	-	4	-	0	2	0	2	2	0	0	0	246	-	-	261
	1963	-	-	-	-	-	-	-	53	48	19	15	1	9	3	0	2	25	-	-	175
	1964	-	-	5	12	18	39	4	28	-	41	47	16	13	14	30	1	4	0	0	272
	1965	-	-	-	-	16	25	-	-	-	-	-	-	-	-	-	-	-	-	-	41
Culex erythro-thorax	1962	-	-	-	1	0	-	1	-	2	0	0	0	0	64	2	0	0	-	-	70
	1963	-	-	-	-	-	-	-	3	1	1	0	0	1	1	1	0	2	-	-	10
	1964	-	-	0	0	1	3	0	4	-	8	7	1	4	3	5	1	1	2	18	58
	1965	-	-	-	-	4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	6
Culex pipiens	1962	-	-	-	6	0	-	0	-	0	0	0	0	0	0	0	0	0	-	-	6
	1963	-	-	-	-	-	-	-	4	0	0	0	0	0	0	0	0	0	-	-	4
	1964	-	-	0	0	1	0	0	0	-	0	1	0	2	0	3	1	0	0	0	8
Aedes nigro-maculis	1963	-	-	-	-	-	-	-	0	0	0	0	0	0	3	0	1	1	-	-	5
	1964	-	-	0	0	0	1	0	1	-	0	0	2	0	0	0	0	0	0	0	4
TOTALS	1962	-	-	-	18	189	-	19	-	25	126	2	10	34	105	331	26	246	-	-	1131
	1963	-	-	-	-	-	-	-	146	165	110	166	7	43	50	43	214	94	-	-	1038
	1964	-	-	30	43	155	216	32	135	-	192	176	38	157	136	87	77	114	40	57	1685
	1965	-	-	-	-	125	114	-	-	-	-	-	-	-	-	-	-	-	-	-	239

*In those years which have been deleted from the chart, samples were taken but no mosquitoes found

Appendix Table 7 (continued)

COMPARISON OF AVERAGE WEEKLY COLLECTIONS OF BITING MOSQUITOES

Lake Front Gun, Fur and Reclamation Club

		June				July					August				September				TOTALS
		1	2	3	4	1	2	3	4	5	1	2	3	4	1	2	3	4	
Aedes dorsalis	1962	-	-	35	48	54	145	105	46	98	188	142	20	20	148	208	48	191	2990
	1965	-	-	-	-	-	-	-	-	0	3	-	18	-	-	-	-	-	21
Culiseta inornata	1962	-	-	17	8	11	39	6	12	6	4	1	3	89	5	17	0	13	231
	1965	-	-	-	-	-	-	-	-	1	2	-	0	-	-	-	-	-	3
Culex tarsalis	1962	-	-	0	5	5	5	20	46	2	4	14	3	11	7	5	0	12	15[illegible]
	1965	-	-	-	-	-	-	-	-	8	8	-	1	-	-	-	-	-	17
Culex erythro-thorax	1962	-	-	0	0	0	0	0	12	0	0	0	0	2	7	13	7	113	154
	1965	-	-	-	-	-	-	-	-	232	168	-	28	-	-	-	-	-	428
TOTALS	1962	-	-	52	61	70	189	131	116	106	196	157	26	122	167	243	55	329	2020
	1965	-	-	-	-	-	-	-	-	241	181	-	47	-	-	-	-	-	469

* No samples were taken at the Lake Front Gun Club during 1963 and 1964

Appendix Table 8

1965 CAR TRAP COLLECTIONS

Farmington Bay Waterfowl Management Area

	July					August				September				TOTALS
	1	2	3	4	5	1	2	3	4	1	2	3	4	
Aedes dorsalis	-	-	-	7	2	32	61	32	270	-	-	-	35	439
Culiseta inornata	-	-	-	64	59	46	50	48	208	-	-	-	3	478
Culex tarsalis	-	-	-	1778	62	70	179	101	411	-	-	-	32	2633
Culex erythrothorax	-	-	-	1379	196	219	477	196	1276	-	-	-	56	3799
Culex pipiens	-	-	-	0	0	5	2	3	143	-	-	-	1	154
Aedes vexans	-	-	-	0	13	0	0	1	4	-	-	-	0	18
TOTALS	-	-	-	3228	332	372	769	381	2312	-	-	-	127	7521

Lake Front Gun, Fur and Reclamation Club

	July					August				September				TOTALS
	1	2	3	4	5	1	2	3	4	1	2	3	4	
Aedes dorsalis	-	-	-	-	2	16	-	14	-	-	-	-	-	32
Culiseta inornata	-	-	-	-	7	17	-	7	-	-	-	-	-	31
Culex tarsalis	-	-	-	-	3	34	-	73	-	-	-	-	-	110
Culex erythrothorax	-	-	-	-	912	921	-	72	-	-	-	-	-	1905
Culex pipiens	-	-	-	-	0	0	-	2	-	-	-	-	-	2
TOTALS	-	-	-	-	924	988	-	168	-	-	-	-	-	2080

Appendix Table 9

SUMMARY OF ALL MOSQUITOES COLLECTED

Species		Lake Front Gun, Fur and Reclamation Club						Wheeler Machinery Company Test Area	
		Larvae Collected		Adult Bite Count		Adults Found in Car Trap		Larvae Collected	
		No.	%	No.	%	No.	%	No.	%
Aedes dorsalis	1962	1225	16	1496	74	-	-	-	-
	1963	1566	49	-	-	-	-	749	30
	1964	1214	57	-	-	-	-	1337	53
	1965	1292	21	21	4.5	32	1.5	1109	43
Culiseta inornata	1962	3949	51	231	11	-	-	-	-
	1963	886	27	-	-	-	-	830	33
	1964	303	14	-	-	-	-	148	6
	1965	1055	17	3	0.5	31	1.5	180	7
Culex tarsalis	1962	2218	29	159	8	-	-	-	-
	1963	758	24	-	-	-	-	883	35
	1964	607	28	-	-	-	-	1021	40
	1965	1289	21	17	3.5	110	5.5	918	35
Culex erythrothorax	1962	67	0.9	154	8	-	-	-	-
	1963	0	0	-	-	-	-	0	0
	1964	1	0.05	-	-	-	-	7	0.3
	1965	2427	40	428	91.5	1905	91.5	221	9
Culex pipiens	1962	2	0.03	0	0	-	-	-	-
	1963	3	0.09	-	-	-	-	0	0
	1964	0	0	-	-	-	-	3	0.1
	1965	7	0.3	0	0	2	0.1	24	1
Aedes fitchii	1965	0	0	0	0	0	0	130	5
Unidentified	1962	213	0.3	0	0	-	-	-	-
	1963	10	0.26	-	-	-	-	44	0.2
	1964	9	0.4	-	-	-	-	26	1
	1965	1	0.1	0	0	0	0	3	0.1
Yearly Totals	1962	7674		2040		-	-	-	-
	1963	3223		-		-	-	2506	
	1964	2134		-		-	-	2542	
	1965	6071		469		2080		2585	
Grand Total		19,102		2509		2080		7633	

*In those years deleted from the chart, samples were taken but no mosquitoes found

Appendix Table 9 (continued)

SUMMARY OF ALL MOSQUITOES COLLECTED

Farmington Bay Waterfowl Management Area

Species		Larvae Collected		Adult Bite Count		Adults Found in Light Trap		Adults Found in Car Trap	
		No.	%	No.	%	No.	%	No.	%
Aedes dorsalis	1962	386	7	398	56	506	11	-	-
	1963	1392	29	163	55	400	39	-	-
	1964	541	26	1105	65	264	35	-	-
	1965	1819	58	852	53	354	11.5	439	6
Culiseta inornata	1962	4344	74	90	13	708	16	-	-
	1963	2715	57	122	41	235	23	-	-
	1964	641	31	196	12	167	22	-	-
	1965	478	15	37	2.5	84	3	478	6.5
Culex tarsalis	1962	794	13	99	14	3001	67	-	-
	1963	558	12	9	3	372	36	-	-
	1964	842	40	271	16	254	34	-	-
	1965	485	15	191	12	1128	37	2633	35
Culex erythrothorax	1962	20	0.3	119	17	216	5	-	-
	1963	6	0.13	3	1	4	0.4	-	-
	1964	2	0.1	120	7	53	7	-	-
	1965	363	12	521	32.5	1187	39	3799	50.5
Culex pipiens	1962	204	3	4	0.5	18	0.4	-	-
	1963	5	0.1	0	0	3	0.3	-	-
	1964	0	0	3	0.2	18	2	-	-
	1965	8	0.3	0	0	42	1.5	154	2
Aedes nigromaculis	1963	0	0	1	0.3	1	0.1	-	-
	1964	0	0	0	0	2	0.3	-	-
Aedes vexans	1965	0	0	1	0.1	263	8.5	18	0.5
Anopheles freeborni	1963	0	0	0	0	1	0.1	-	-
	1965	0	0	0	0	5	0.1	0	0
Unidentified	1962	161	2	0	0	0	0	-	-
	1963	53	1.1	0	0	0	0	-	-
	1964	54	3	0	0	0	0	-	-
	1965	0	0	0	0	0	0	0	0
Yearly Totals	1962	5909		710		4449			
	1963	4729		298		1016			
	1964	2080		1695		758			
	1965	3153		1602		3063		7521	
Grand Total	15,871								

*In those years deletedfrom the chart, samples were taken but no mosquitoes found

Appendix Table 9 (continued)

SUMMARY OF ALL MOSQUITOES COLLECTED

Species		South Davis County Sewage Treatment Plant				Davis County MAD Office	
		Adult Bite Count		Adults Found in Light Trap		Adults Found in Light Trap	
		No.	%	No.	%	No.	%
Aedes dorsalis	1962	613	54	367	19	30	1
	1963	773	74	1136	34	19	2
	1964	1170	69	437	16	14	3
	1965	171	71.5	181	26.5	-	-
Culiseta inornata	1962	181	16	931	47	487	20
	1963	71	7	1466	44	42	5
	1964	173	10	1234	46	23	4
	1965	21	9	280	41	-	-
Culex tarsalis	1962	261	23	623	32	1882	78
	1963	175	17	692	21	452	58
	1964	272	16	907	34	403	79
	1965	41	17	191	28	-	-
Culex erythrothorax	1962	70	6	28	1	4	0.2
	1963	10	0.9	13	0.4	3	0.4
	1964	58	3	96	4	9	2
	1965	6	2.5	25	3.5	-	-
Culex pipiens	1962	6	0.5	21	1	6	0.2
	1963	4	0.4	2	0.06	20	3
	1964	8	0.5	27	1	63	12
	1965	0	0	0	0	-	-
Aedes nigromaculis	1963	5	0.5	8	0.2	1	0.1
	1964	4	0.2	2	0.7	0	0
Anopheles freeborni	1962	0	0	0	0	1	0.05
	1963	0	0	0	0	1	0.1
	1965	0	0	10	1.5	-	-
Unidentified	1962	0	0	0	0	0	0
	1963	0	0	0	0	245	31
	1964	0	0	0	0	0	0
	1965	0	0	0	0	-	-
Yearly Totals	1962	1131		1970		2410	
	1963	1038		3317		783	
	1964	1685		2703		512	
	1965	239		687		-	
Grand Total		4093		14,877		3705	

* In those years deleted from the chart, samples were taken but no mosquitoes found

Appendix Table 9 (continued)

SUMMARY OF ALL MOSQUITOES

All Areas Combined

Species		Larvae Collected		Adult Bite Count		Adults Found in Light Trap		Adults Found in Car Trap	
		No.	%	No.	%	No.	%	No.	%
Aedes dorsalis	1962	1611	12	2507	65	903	10	-	-
	1963	3707	35	936	70	1555	30	-	-
	1964	3092	45	2275	67	715	18	-	-
	1965	4220	36	1044	45	535	14	471	5
Culiseta inornata	1962	8293	61	502	13	2126	24	-	-
	1963	4431	43	193	14	1743	34	-	-
	1964	1092	16	369	11	1424	36	-	-
	1965	1713	15	61	3	364	10	509	5
Culex tarsalis	1962	3012	22	519	13	5506	62	-	-
	1963	2199	21	184	14	1516	30	-	-
	1964	2470	37	543	16	1564	39	-	-
	1965	2692	23	249	11	1319	35	2743	29
Culex erythrothorax	1962	87	1	343	9	248	3	-	-
	1963	6	0.1	13	1	20	0.04	-	-
	1964	10	0.1	178	5	158	4	-	-
	1965	3011	25	955	41	1212	32	5704	59
Culex pipiens	1962	206	2	10	0.3	45	0.05	-	-
	1963	8	0.1	4	0.03	25	0.05	-	-
	1964	3	0.04	11	0.3	108	3	-	-
	1965	39	0.3	0	0	42	0.1	156	2
Aedes fitchii	1962	0	0	-	-	0	0	-	-
	1965	130	1	0	0	0	0	0	0
Aedes nigromaculis	1963	0	0	6	0.04	10	0.02	-	-
	1964	0	0	4	0.1	4	0.1	-	-
Aedes vexans	1965	0	0	1	0.05	263	7	18	0.02
Anopheles freeborni	1962	0	0	-	-	1	0.001	-	-
	1963	0	0	-	-	2	0.04	-	-
	1965	0	0	0	0	15	0.3	0	0
Unidentified	1962	374	3	-	-	0	0	-	-
	1963	107	1	-	-	245	5	-	-
	1964	89	1	0	0	0	0	-	-
	1965	4	0.03	0	0	0	0	0	0
Yearly Totals	1962	13583		3881		8829		-	-
	1963	10458		1336		5116		-	-
	1964	6756		3380		3973		-	-
	1965	11809		2310		3750		9601	
Grand Total		42,606		10,907		21,668		9601	

*In those years deleted from the chart, samples were taken but no mosquitoes found

Appendix Table 10

1965 MOSQUITO PRODUCTION IN DIFFERENT VEGETATION

Station 6 (Lake Front Gun, Fur and Reclamation Club)

	June 28	July 6	July 14	July 20	July 27	Aug. 3	Aug. 10	Aug. 16	TOTALS
6-1 Salt Grass									
Number of dips	40	40	20	40	40	40	40	10	270
No. of mosquitoes	33	0	64	17	21	23	47	10	215
Average/dip	0.82	0	3.20	0.42	0.52	0.58	1.17	1	0.80
6-2 Salt Grass and Olney's Bulrush									
Number of dips	40	40	40	40	40	40	40	10	290
No. of mosquitoes	15	14	0	32	23	4	76	4	163
Average/dip	0.38	0.35	0	0.80	0.58	0.1	1.9	0.1	0.58
6-3 Olney's Bulrush									
Number of dips	40	40	40	40	40	40	40	10	290
No. of mosquitoes	0	2	0	59	14	48	28	4	155
Average/dip	0	0.05	0	1.48	0.35	1.2	0.70	0.1	0.53
6-4 Submergent Vegetation									
Number of dips	40	40	40	40	40	40	40	10	290
No. of mosquitoes	0	0	0	0	0	0	0	0	0
Average/dip	0	0	0	0	0	0	0	0	0
6-5 Salt Grass and Alkali Bulrush									
Number of dips	40	40	40	40	-	40	-	40	240
No. of mosquitoes	0	3	2	0	-	3	-	39	47
Average/dip	0	0.08	0.05	0	-	0.08	-	1	0.2
6-6 Alkali Bulrush									
Number of dips	40	40	40	40	40	40	40	10	290
No. of mosquitoes	0	0	2	4	0	0	64	0	70
Average/dip	0	0	0.05	0.1	0	0	1.6	0	0.24

Appendix Table 10 (cont.)

1965 MOSQUITO PRODUCTION IN DIFFERENT VEGETATION

Station 8 (Lake Front Gun, Fur and Reclamation Club)

	June 30	July 6	July 15	July 21	July 27	Aug. 3	Aug. 10	TOTALS
8-1 Salt Grass								
Number of dips	40	40	40	40	40	40	40	280
No. of mosquitoes	2	0	8	16	12	25	122	185
Average/dip	0.05	0	0.2	0.4	0.3	0.63	3.05	0.66
8-2 Salt Grass and Cattails								
Number of dips	40	40	40	20	40	40	40	260
No. of mosquitoes	0	0	115	110	60	0	122	407
Average/dip	0	0	2.88	5.5	1.5	0	3.05	1.57
8-3 Olney's Bulrush								
Number of dips	40	40	40	40	-	40	40	240
No. of mosquitoes	25	8	1	0	-	0	21	55
Average/dip	0.63	0.2	0.02	0	-	0	0.53	0.23
8-4 Salt Grass and Olney's Bulrush								
Number of dips	40	40	40	0	40	40	40	240
No. of mosquitoes	23	5	318	0	25	141	36	548
Average/dip	0.57	0.12	7.95	0	0.63	3.53	0.9	2.28
8-5 Salt Grass and Alkali Bulrush								
Number of dips	40	40	40	40	40	40	40	280
No. of mosquitoes	0	5	0	34	34	47	115	235
Average/dip	0	0.13	0	0.85	0.85	1.18	2.87	0.84
8-6 Submergent Vegetation								
Number of dips	40	40	40	40	40	40	40	280
No. of mosquitoes	0	0	0	0	0	0	0	0
Average/dip	0	0	0	0	0	0	0	0
8-7 Cattails								
Number of dips	40	40	40	14	0	6	10	150
No. of mosquitoes	3	0	5	0	0	10	1	19
Average/dip	0.08	0	0.13	0	0	1.67	0.1	0.13
8-8 Alkali Bulrush								
Number of dips	40	40	40	40	0	40	40	240
No. of mosquitoes	0	0	0	0	0	14	27	41
Average/dip	0	0	0	0	0	0.35	0.68	0.17

Appendix Table 11

LIST OF BIRDS

Seasons Present

PR - Permanent Resident
Sp - Spring
S - Summer
F - Fall
W - Winter

Abundance

a - abundant
c - common
o - occasional
r - rare

Common Name	Scientific Name	Seasons Present and Abundance
Common Loon	*Gavia immer* (Brunnich)	SpF-o
Horned Grebe	*Podiceps auritus* (Linn.)	SpF-r
Eared Grebe	*Podiceps caspicus* (Hab.)	SpSF-c
Western Grebe	*Aechmophorus occidentalis* (Lawrence)	SpSF-c
Pied billed Grebe	*Podilymbus podiceps* (Linn.)	PR-c
White Pelican	*Pelecanus erythorhynchos* Gmelin	SpSF-a
Double-crested Cormorant	*Phalacrocorax auritus* (Lesson)	SpSF-c
Great Blue Heron	*Ardea herodias treganzai* Court	SpSF-c
Green Heron	*Butorides virescens* Linnaeus	SpSF-r
Common Egret	*Casmerodius albus* (Linn.)	SpF-r
Snowy Egret	*Leucophoyx thula brewsteri* (Thayer & Bangs)	SpSF-c
Black-crowned Night Heron	*Nycticorax nycticorax hoactli* (Gmelin)	SpSF-c
American Bittern	*Botaurus lentiginosus* (Rackett)	SpSF-o
White-faced Ibis	*Plegadis chihi* (Vieillot)	SpSF-a
Whistling Swan	*Olor columbianus* (Ord)	SpF-a
Canada Goose	*Branta canadensis moffitti* Aldrich	PR-a
Canada Goose	*Branta canadensis interior* Todd	SpF-o
Canada Goose	*Branta canadensis traverneri* Delacour	SpF-r
White-fronted Goose	*Anser albifrons* (Scopoli)	SpF-r
Snow Goose	*Chen hyperborea hyperborea* (Pallas)	SpF-c
Ross' Goose	*Chen rossii* (Cassin)	F-r
Mallard	*Anas platyrhynchos platyrhynchos* Linn.	PR-a
Black Duck	*Anas rubripes* Brewster	F-r
Gadwall	*Anas strepera* Linn.	SpSF-a
Pintail	*Anas acuta* Linn.	SpSF-a
Green-winged Teal	*Anas carolinensis* Gmelin	SpF-a
Blue-winged Teal	*Anas discors* Linn.	SpSF-o
Cinnamon Teal	*Anas cyanoptera* Vieillot	SpSF-a
Baldpate	*Mareca americana* (Gmelin)	SpSF-a
Shoveler	*Spatula clypeata* (Linn.)	SpSF-a
Wood Duck	*Aix sponsa* (Linn.)	SpF-r
Redhead	*Aythya americana* (Eyton)	SpSF-a
Ring-necked Duck	*Aythya collaris* (Donovan)	SpF-o
Canvasback	*Aythya valisineria* (Wilson)	SpF-o
Greater Scaup	*Aythya marila neartica* Stejneger	SpF-r
Lesser Scaup	*Aythya affinis* (Eyton)	WSpF-c
Common Goldeneye	*Bucephala clangula americana* (Bonaparte)	SpF-c
Barrow's Goldeneye	*Bucephala islandica* (Gmelin)	SpF- r
Bufflehead	*Bucephala albeola* (Linn.)	SpF-o
Oldsquaw	*Clangula hymalis* (Linn.)	F-r

Appendix Table 11 (cont.)

LIST OF BIRDS

Common Name	Scientific Name	Seasons Present and Abundance
White-winged Scoter	*Melanitta deglandi* (Bonaparte)	F-r
Surf Scoter	*Melanitta perspicillata* (Linn.)	F-r
Ruddy Duck	*Oxyura jamaicensis rubida* (Wilson)	SpSF-c
Hooded Merganser	*Lophodytes cucullatus* (Linn.)	SpF-r
Common Merganser	*Mergus merganser americanus* Cassin	SpF-c
Red-breasted Merganser	*Mergus serrator* Linn.	SpF-c
Turkey Vulture	*Cathartes aura teter* Friedmann	SpSF-o
Red-tailed Hawk	*Buteo jamaicensis calurus* (Cassin)	SpSF-o
Swainson's Hawk	*Buteo swainsoni* Bonaparte	SpSF-o
Ferruginous Hawk	*Buteo regalis* (Gray)	SpSF-o
Golden Eagle	*Aquila chrysaetos cnadensis* (Linn.)	SpSF-o
Bald Eagle	*Haliaeetus leucocephalus alascanus* Townsend	W-r
Marsh Hawk	*Circus cyaneus hudsonius* (Linn.)	SpSF-c
Prairie Falcon	*Falco mexicanus Schlegel*	SpSF-r
Peregrine Falcon	*Falco peregrinus anatum* Bonaparte	PR-o
Sparrow Hawk	*Falco sparverius* Linn.	SpSF-o
Ring-necked Pheasant	*Phasianus colchicus* Linn.	PR-c
Virginia Rail	*Rallus limicola* Vieillot	SpSF-o
Sora	*Porzana carolina* (Linn.)	SpSF-o
Common Gallinule	*Gallinula chloroous chachinnans* Bangs	S-r
American Coot	*Fulica americana* Gmelin	SpSF-a
Snowy Plover	*Charadrius alexandrinus nivosus* (Cassin)	SpSF-o
Killdeer	*Charadrius vociferus* Linn.	SpSF-a
Black-bellied Plover	*Squatarola squatarola* (Linn.)	SpSF-a
Common Snipe	*Capella gallinago delicata* (Ord)	SpSF-o
Long-billed Curlew	*Numenius americanus* Bechstein	SpSF-c
Spotted Sandpiper	*Actitis macularia* (Linn.)	SpSF-o
Solitary Sandpiper	*Tringa solitaria* (Wilson)	SpF-r
Willet	*Catoptrophorus semipalmatus inornatus*(Brewster)	SpSF-c
Greater Yellow-legs	*Totanus melanoleucus* (Gmelin)	SpF-c
Lesser Yellow-legs	*Totanus flavipes* (Gmelin)	SpF-o
Pectoral Sandpiper	*Erolia melanotos* (Vieillot)	SpF-r
Baird's Sandpiper	*Erolia bairdii* (Coues)	SpF-c
Least Sandpiper	*Erolia minutilla* (Vieillot)	SpF-c
Long-billed Dowitcher	*Limnodromus scolopaceus* (Say)	SpF-a
Western Sandpiper	*Ereunetes mauri* Cabanis	SpF-c
Marbled Godwit	*Limosa fedoa* (Linn.)	SpF-c
Sanderling	*Crocethia alba* (Pallas)	SpF-o
Avocet	*Recurvirostra americana* Gmelin	SpSF-a
Black-necked Stilt	*Himantopus mexicanus* (Muller)	SpSF-a
Wilson's Phalarope	*Steganopus tricolor* Vieillot	SpSF-c
Northern Phalarope	*Lobipes lobatus* (Linn.)	SpF-c
California Gull	*Larus californicus* Lawrence	SpSF-a
Ring-billed Gull	*Larus delawarensis* Ord	W-c
Franklin Gull	*Larus pipixcan* Wagler	SpSF-a
Forster's Tern	*Sterna forsteri* Nuttall	SpSF-c
Caspian Tern	*Hydroprogne caspia* (Pallas)	SpSF-c
Black Tern	*Chlidonias niger* (Linn.)	SpSF-o

Appendix Table 11 (cont.)

LIST OF BIRDS

Common Name	Scientific Name	Seasons Present and Abundance
Mourning Dove	*Zenaidura macroura marginella* (Woodhouse)	SpSF-o
Great Horned Owl	*Bubo virginianus occidentalis* Stone	SpFW-o
Burrowing Owl	*Speotyto cunicularia hypugaea* (Bonaparte)	SpSF-o
Long-eared Owl	*Asio otus* (Linn.)	SpF-o
Short-eared Owl	*Asio flammeus* (Pontoppidan)	PR-c
Common Nighthawk	*Chordeiles minor hesperis* Grinnell	SpSF-c
Broad-tailed Hummingbird	*Selasphorus platycercus platycercus* (Swainson)	S-o
Rufous Hummingbird	*Selasphorus rufus* (Gmelin)	SpF-r
Belted Kingfisher	*Megaceryle alcyon caurina* (Grinnell)	SpSF-o
Red-shafted Flicker	*Colaptes cafer* (Gmelin)	PR-o
Western Kingbird	*Tyrannus verticalis* Say	SpSF-c
Say's Phoebe	*Sayornis saya* (Bonaparte)	SpSF-o
Traill's Flycatcher	*Empidonax traillii* (Audubon)	SpF-o
Horned Lark	*Eremophila alpestris* utahensis (Behle)	PR-o
Violet-green Swallow	*Tachycineta thalassina* (Swainson)	SpSF-c
Tree Swallow	*Iridoprocne bicolor* (Vieillot)	SpF-o
Bank Swallow	*Riparia riparia riparia* (Linn.)	SpSF-c
Barn Swallow	*Hirundo rustica* Linn.	SpSF-a
Rough-wing Swallow	*Stelgidopteryx rufficollis* (Audubon)	SpSF-c
Cliff Swallow	*Petrochelidon pyrrhonota hypopdia* Oberholser	SpSF-o
Purple Martin	*Progne subis* (Linnaeus)	SF-o
Black-billed Magpie	*Pica pica hudsonia* (Sabine)	PR-c
Common Raven	*Corvus corax sinuatus* Wagler	PR-o
Common Crow	*Corvus brachyrhynchos hesperis* Ridgway	SpFW-o
Long-billed Marsh Wren	*Telmatodytes palustris plesius* (Oberholser)	SpSF-a
Robin	*Turdus migratorius propinquus* Ridgway	SpSF-c
Mountain Bluebird	*Sialia currocoides* (Bechstein)	SpF-o
Water Pipit	*Anthus spinoletta* (Linnaeus)	SpF-o
Bohemian Waxwing	*Bombycilla garrula pallideceps* Reichenow	W-o
Cedar Waxwing	*Bombycilla cedrorum* Vieillot	W-o
Northern Shrike	*Lanius excubitor* Linnaeus	W-r
Loggerhead Shrike	*Lanius ludovicianus* Linn.	W-r
Starling	*Sturnus vulgaris* Linn.	PR-o
Yellowthroat	*Geothlypis trichas occidentalis* Brewster	SpSF-o
House Sparrow	*Passer domesticus domesticus* (Linn.)	PR-c
Bobolink	*Dolichonyx oryzivorus* (Linn.)	SpSF-o
Western Meadowlark	*Sturnella neglecta* Audubon	PR-c
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus* (Bonaparte)	SpSF-a
Redwinged Blackbird	*Agelaius phoeniceus fortis* Ridgway	SpSF-a
Bullock's Oriole	*Icterus bullockii* (Swainson)	SpSF-o
Brewer's Blackbird	*Euphagus cyanocephalus* (Wagler)	SpSF-a
Brown-headed Cowbird	*Molothrus ater* (Boddaert)	SpSF-c
Lazuli Bunting	*Passerina amoena* (Say)	SpF-o
White-crowned Sparrow	*Zonotrichia leucophrys* (Forster)	SpF-c
House Finch	*Carpodacus mexicanus* frontalis (Say)	SpSF-o
American Gold Finch	*Spinus tristis pallidus* Mearns	SpSF-o
Savannah Sparrow	*Passerculus sandwichensis nevadensis* Grinnell	SpSF-o
Vesper Sparrow	*Pooecetes gramineus confinis* Baird	SpSF-o
Lark Sparrow	*Chondestes grammacus strigatus* Swainson	SpSF-o

Appendix Table 11 (cont.)

LIST OF BIRDS

Common Name	Scientific Name	Seasons Present and Abundance
Slate-colored Junco	*Junco hyemalis cismontanus* Dwight	W-o
Tree Sparrow	*Spizella arborea* (Wilson)	FW-c
Chipping Sparrow	*Spizella passerina arizonae* Coues	SpSF-o
White-crowned Sparrow	*Zonotrichia leucophrys* (Forster)	SpF-c
Song Sparrow	*Melospiza melodia montana* Henshaw	SpSF-o

Appendix Table 12

LIST OF MAMMALS

Water Shrew	*Sorex palustris navigator* (Baird)
Vagrant Shrew	*Sorex vagrans obscurus* Merriam
Silvery-haired Bat	*Lasionycteris noctivagans* (Le Conte)
Hoary Bat	*Lasiurus cinereus cinereus* (Beauvois)
Big Brown Bat	*Eptesicus fuscus pallidus* Young
Bats	*Myotis* sp.
Black-tailed Jack Rabbit	*Lepus californicus deserticola* Mearns
Cottontail Rabbit	*Sylvilagus* sp.
Merriam Rock Squirrel	*Citellus variegatus utah* Merriam
Townsend Ground Squirrel	*Citellus townsendii mollis* (Kennicott)
Uinta Ground Squirrel	*Citellus armatus* (Kennicott)
Botta Pocket Gopher	*Thomomys bottae albicaudatus* Hall
Ord Kangaroo Rat	*Dipodomys ordii marshalli* Goldman
Great Basin Pocket Mouse	*Perognathus parvus olivaceus* Merriam
Muskrat	*Ondatra zibethicus osoyoosensis* (Lord)
Western Harvest Mouse	*Reithrodontomys megalotis megalotis* (Baird)
Northern Grasshopper Mouse	*Onychomys leucogaster utahensis* Goldman
Deer Mouse	*Peromyscus maniculatus sonoriensis* (Le Conte)
Pennsylvanian Meadow Mouse	*Microtus pennsylvanicus modestus* (Baird)
Montana Meadow Mouse	*Microtus montanus nanus* Merriam
House Mouse	*Mus musculus* Linnaeus
Norway Rat	*Rattus norvegicus norvegicus* (Berkenhout)
Coyote	*Canis latrans lestes* Merriam
Kit Fox	*Vulpes macrotis nevadensis* Goldman
Badger	*Taxidea taxus taxus* (Schreber)
Striped Skunk	*Mephitis mephitis major* (Howell)
Long-tailed Weasel	*Mustela frenata nevadensis* Hall
Domestic Mink	*Mustela domesticus*
Mule Deer	*Odocoileus hemionus hemionus* (Rafinesque)

Appendix Table 13

LIST OF FISH

Common Name	Scientific Name
Carp	*Cyprinus carpis* (Linnaeus)
Utah Chub	*Gila artraria* (Girard)
Least Chub	*Iotichthys phlegethontis* (Cope)
Channel Catfish	*Ictalurus puctatus* (Rafinesque)
Black Bullhead	*Ictalurus melas* (Rafinesque)
Mosquito Fish	*Gambusia affinis affinis* (Baird and Girard)
Green Sunfish	*Lepomis cyanellus* Rafinesque

The rainwater killifish, *Lucania parva* (Baird and Girard), was found in large numbers in the Timpie Waterfowl Management Area, Tooele County, Utah, but was not found in the study areas.

Appendix Table 14

1962-1965 SUMMARY OF WATERFOWL BAG CHECKS MADE ON FARMINGTON BAY WATERFOWL MANAGEMENT AREA

	1962*	1963*	1964*	1965**
Total Hunters	2180	2853	3194	2500
Total Ducks	6498	6521	4544	7700
Ducks/Hunter	2.98	2.28	1.42	3.08
Total Geese	67	33	46	9

* Bag Checks made on the first weekend of the hunting season.
** Bag Checks made on the first day of the hunting season.

Appendix Table 15

1960-1965 NUMBER OF MUSKRATS TRAPPED ON FARMINGTON BAY WATERFOWL MANAGEMENT AREA

Trapping Season (J[illegible]April)	Number of Muskrats
1960	5926
1961	4242
1962	5189
1963	5564
1964	9080
1965	9657

Appendix Table 16

1965 RESULTS OF WATERFOWL SURVEYS ON LARVAL SAMPLING STATIONS
Lake Front Gun, Fur and Reclamation Club

Sampling Station I

Prenesting and General Utilization: (April 25-August 20)

	Activities				
Species	Courting	Feeding	Loafing	Nesting	Brood rear
Pintail	0	0	35	2	0
Cin. Teal	0	0	18	2	0
Shoveler	0	2	24	1	1
Gadwall	0	2	3	0	0
Mallard	0	0	18	2	0
Red Head	0	0	0	1	0
TOTALS	0	4	98	8	1

Information above is from 16 different observations.

Due to the late initiation of the project, conclusive prenesting data was not available. Only a few areas indicated any possible trends. Area 1 showed little usage by courting birds, feeding activities were also minor. The loafing activities were somewhat better, but much of this was on the edge of the dike which borders the area. General utilization for the entire study was also included in the information given above.

Nesting Activities: (June-July)

Individual nesting data

		Outcome			
Nest No.	Species	Success	Failure	Cause of Failure	Vegetative Type of Nest
1	Cin. Teal		X	desertion	Distichlis spicata
2	Mallard		X	flooding	" "
3	Mallard		X	flooding	" "
4	Redhead		X	gulls	" "
5	Shoveler		X	flooding	" "
6	Cin. Teal	X			" "
7	Pintail	X			" "
8	Pintail		X	flooding	" "

Nesting Mortality

8 Total nests
6 Nests lost

Mortality rate 6/8 x 100 = 75%
Nesting success = 25%

Nesting Productivity

Size of area--approximately 6 acres
8 Total nesting attempts
Total successful nests--2
1.3 nesting attempts/acre
Area productivity--0.33 nests/acre

Appendix Table 16 (cont.)

Brood Rearing: (July 6 - August 20)

There was only only one brood observed on this area during the entire study. A hen Shoveler and seven ducklings were recorded on the 1st of August.

Sampling Station I Vegetation and Water Conditions

Vegetation type--*Distichlis spicata* var. *stricta* (Salt Grass)

Species composition:	Percent of total
Distichlis spicata	99.5%
Traces:	00.5
Hordem brachyantherum	
Rumex crispus	
Scirpus olneyi	
Atriplex patula	
Sarcobatus vermiculatus	
	100%

Area Cover Percentages:

Surface exposure	Percent of total
Vegetation	87%
Bare ground	3
Open water	10
	100%

Water coverage--flooding--70%

Water stability

Water conditions tended to fluctuate throughout the entire season, slacking off slightly after June 15 when water runoff presumably reached its peak. Flooding was a common cause of nesting losses early in the nesting season, and continued almost through the entire nesting activities.

Area Rating

Due to the fluctuating water conditions and the type of vegetation which exists in this area, this area was given a poor rating for waterfowl activities. A poor rating was given for general nesting, a fair rating for renesting attempts in that the two successful nests were renesting attempts or late nestings and a poor rating was given for brood rearing.

Appendix Table 16 (cont.)

Sampling Station 2

Prenesting and General Utilization: (April 25-August 20)

Species	Courting	Feeding	Loafing	Nesting	Brood rear
Redhead	14	4	2	0	1
Cin. Teal	9	6	1	0	1
Shoveler	0	0	1	0	0
Mallard	0	4	0	0	0
TOTALS	23	14	4	0	2

Information above is from 16 different observations.

This area, though no ducks were found nesting, had some attraction to courting parties of Redheads and Cinnamon Teal. Most of these parties were well along in the prenesting season and consisted mainly of groups averaging four drakes and one hen.

There was some feeding observed but was not extensive enough to merit any rating as a feeding area. Lack of high ground explains the little utilization by loafing birds. This area seemed to favor Coot activities in that 16 Coot nestings were recored and 17 broods were observed at various time checks.

Nesting Activities: (June 1-July 5)

Individual nesting data

Nest No.	Species	Outcome Success	 Failure	Cause of Failure	Vegetative Type of Nest
1	Coot	X			*Distichlis spicata*
2	"	X			" "
3	"	X			" "
4	"	X			" "
5	"	X			*Scirpus acutus*
6	"		X	desertion	" "
7	"	X			*Distichlis spicata*
8	"	X			*Scirpus acutus*
9	"		X	flooding	*Distichlis spicata*
10	"	X			" "
11	"		X	flooding	" "
12	"	X			*Scirpus acutus*
13	"	X			*Distichlis spicata*
14	"	X			" "
15	"		X	unknown	" "
16	"	X			*Scirpus acutus*

Nesting Mortality

16 Total nests (Coots)
4 Nests lost

Mortality rate 4/16 x 100 = 25%
Nesting success = 75%

Appendix Table 16 (cont.)

Nesting Productivity

Size of area--approximately 4.3 acres
Total successful nests--12
16 Total nesting attempts (Coots)
3.7 nesting attempts/acre
Area productivity--2.8 nests/acre

Brood Rearing: (July 6-August 20)

Only two duck broods were sighted on the area during the course of the study. They were a Cinnamon Teal brood of nine ducklings escorted by a hen and a Redhead hen with seven ducklings. There were also some 17 broods of Coots sighted and recorded during the study. Their size varied from one to six young and the average was 4.4 young per brood.

This area did not appear attractive to hens that were brooding, possibly because there was a lack of cover vegetation preferred by brooding hens. Most of the young Coots recorded were from successfully hatched clutches of the area.

Sampling Station 2 Vegetation and Water Conditions

Vegetation type--Distichlis spicata var. stricta (Salt Grass)

Species composition:	Percent of total
Distichlis spicata	95%
Traces:	2
Hordeum jubatum	
Hordeum brachyantherum	
Scirpus paludosus	
Scirpus olneyi	
Eleocharis macrostaycha	
Typha sp.	
	100%

Area Cover Percentages:

Surface exposure	Percent of total
Vegetation	66%
Open Water	34
Bare Ground	0
	100%

Water coverage--flooding--100%

Water stability

Water conditions tended to fluctuate throughout the entire study, but the area remained under water with no ground exposure throughout

Appendix Table 16 (cont.)

the season. The water level varied from 2 inches to 14 inches, with a fluctuation of 4-6 inches. Flooding did occur in some of the Coot nestings. The water level remained too high for the vegetation type to afford any duck nesting.

Area Rating

Due to the constant flooding of Sampling Station 2 and the lack of supporting vegetation, the area was rated as poor for all waterfowl activities except some courting and little feeding of ducks. It seemed to offer more attractive conditions to Coot nesting and brooding.

Sampling Station 6

Prenesting and General Utilization: (April 25-August 20)

	Activities				
Species	Courting	Feeding	Loafing	Nesting	Brood rear
Cin. Teal	28	7	4	3	1
Mallard	10	2	0	1	0
Redhead	12	8	0	0	0
Blue Wing Teal	3	0	0	0	0
Pintail	2	17	0	1	0
Gadwall	5	2	0	0	0
Shoveler	0	3	0	0	0
TOTALS	60	39	4	5	1

Information above is from 16 different observations.

The waterfowl study for Sampling Station 6 included the Salt Grass area adjacent to the dike and also extended into the bullrush area just west of the sampling station sign. Some nesting was found in the Salt Grass but the majority was in the outlying bullrush.

Courting and feeding activities were quite frequent while loafing, nesting and brood rearing were somewhat minor.

Nesting Activities: (June 1--July 5)

Individual nesting data

		Outcome			
Nest No.	Species	Success	Failure	Cause of Failure	Vegetative Type of Nest
1	Coot	X			*Distichlis spicata*
2	Mallard	X			*Scirpus olneyi*
3	Coot		X	desertion	*Scirpus paludosus*
4	Pintail	X			" "
5	Cin. Teal		X	flooding	" "
6	Cin. Teal	X			*Scirpus olneyi*
7	Cin. Teal		X	desertion	" "

Appendix Table 16 (cont.)

Nesting Mortality

Ducks

5 Total nests	Mortality rate 2/5 x 100 = 40%
2 Nests lost	Nesting success = 60%

Coots

2 Total nests	Mortality rate 1/2 x 100 =50%
1 Nest lost	Nesting success = 50%

Nesting Productivity

Size of area--approximately 3.4 acres

Total nesting attempts:
Ducks--5
Coots--2

Total successful nests:
Ducks--3
Coots--1

Nesting attempts/acre:
Ducks--1.5 nests/acre
Coots--0.6 nests/acre

Area productivity:
Ducks--0.88 successful nests/acre
Coots--0.3 successful nests/acre

Brood Rearing: (July 6-August 20)

Only one duck brood was observed on the area. It was a Cinnamon Teal brood of nine ducklings. Five Coot broods were also seen during the study.

The lack of utilization by brooding hens could possibly be due to the water--vegetation relationship, in that there was little area which afforded adequate water with good vegetative cover. There was a presence of some feed plants, but not in such abundance that extensive utilization could exist.

Sampling Station 6 Vegetation and Water Conditions

Vegetation type--Mixed: Distichlis spicata var. stricta & Scirpus sps.

Species composition:	Percent of total
Distichlis spicata	53%
Scirpus olneyi	30
Scirpus paludosus	15
Traces:	2
Hordeum jubatum	
Puccinellia distans	
	100%

Area Cover Percentages:

Surface exposure	Percent of total
Vegetation	65%
Open water	20
Bare ground	15
	100%

Appendix Table 16 (cont.)

Water coverage--flooding--80%

Water stability

Adequate information was not kept on the water conditions throughout the study. There were only slight changes of the water level during the latter part of the season. Only one nest of those observed was lost due to flooding. In the majority of the nests, the vegetation was such that nest construction was made several inches above water.

Area Rating

As a courting and feeding area, Sampling Station 6 received a good rating. Other activities were of less importance. Only one brood was seen, and the number of successful nests was 0.88/acre. As a general rating for waterfowl, Sampling Station 6 should be considered as fair.

Sampling Station 7

Prenesting and General Utilization: (April 25-August 20)

Species	Activities Courting	Feeding	Loafing	Nesting	Brood rear
Mallard	0	1	4	0	0
Redhead	0	7	6	2	0
Cin. Teal	0	3	5	0	2
Pintail	0	0	4	1	0
TOTALS	0	11	19	3	2

Information above is from 16 different observations.

This area showed little attraction to waterfowl. None of the activity groups were of any significance. Some 8 Coot nests were recorded, all being in Distichlis spicata and Scirpus paludosus with mixed vegetation.

Nesting Activities: (June 1-July 5)

Individual nesting data

Nest No.	Species	Outcome Success	Failure	Cause of Failure	Vegetative Type of Nest
1	Coot	X			Dist./Scir. (mixed)
2	"	X			Distichlis spicata
3	Redhead		X	flooding	Dist./Scir. (mixed)
4	Coot	X			Distichlis spicata
5	"		X	desertion	" "
6	Redhead	X			Dist./Scir. (mixed)
7	Coot		X	desertion	" "

Appendix Table 16 (cont.)

Nest No.	Species	Outcome Success	 Failure	Cause of Failure	Vegetative Type of Nest
8	Pintail		X	gulls	*Dist.*/*Scir.* (mixed)
9	Coot	X			" " "
10	"	X			" " "
11	"	X			" " "
12	"	X			*Distichlis spicata*

Nesting Mortality

Ducks
3 Total nests — Mortality rate 2/3 x 100 = 67%
2 Nests lost — Nesting success = 33%

Coots
9 Total nests — Mortality rate 2/9 x 100 = 22%
2 Nests lost — Nesting success = 78%

Nesting Productivity

Size of area--approximately 2.4 acres

Total nesting attempts:
Ducks--3
Coots--9

Total successful nests:
Ducks--1
Coots--7

Nesting attempts/acre:
Ducks--1.2 nests/acre
Coots--3.7 nests/acre

Area productivity:
Ducks--0.4 successful nests/acre
Coots--2.9 successful nests/acre

Brood Rearing: (July 6-August 20)

Only two broods were observed on Sampling Station 7 during the study. Both were Cinnamon Teal and consisted of seven ducklings in one and five ducklings in the other. There was no other brood utilization by ducks, but some five Coot broods were recorded at various surveys throughout the study.

Sampling Station 7 Vegetation and Water Conditions

Vegetation type--Mixed: *Dist. spic.* var. *stricta* & *Scir. paludosus*

Species composition:	Percent of total
Distichlis spicata	55%
Scirpus paludosus	43
Polypogon monspeliensis	1
Traces:	1
Hordeum jubatum	
Eleocharis acicularis	
	100%

Appendix Table 16 (cont.)

Area Cover Percentages:

Surface exposure	Percent of total
Vegetation	77%
Open water	20
Bare ground	3
	100%

Reproduced from best available copy.

Water coverage--flooding--85%

Water stability

There was some changing of the water levels during the course of the study, but not to the extent as to affect waterfowl nesting. In much of the area, both Salt Grass and Alkali Bullrush (Scirpus paludosus) was covered by water throughout the season. Lack of supporting vegetation was a possible reason for low waterfowl nesting activities.

Area Rating

Sampling Station 7 is of poor value for all waterfowl activities. Light vegetation of Distichlis spicata and Scirpus paludosus, neither of a good supporting type, and the extensive water coverage seemed to be the controlling factors. The activities most widely participated in were loafing and resting. The overall rating for Sampling Station 7 was poor.

Sampling Station 8

Prenesting and General Utilization: (April 25-August 20)

	Activities				
Species	Courting	Feeding	Loafing	Nesting	Brood rear
Mallard	16	23	4	8	4
Cin. Teal	30	49	7	8	3
Blue Wing Teal	4	9	2	0	0
Redhead	60	47	9	11	3
Pintail	22	40	5	6	2
Gadwall	6	18	4	2	0
Shoveler	6	16	9	5	2
Ruddy	10	5	0	3	6
TOTALS	154	207	40	43	20

Information above is from 16 different observations.

Waterfowl used Sampling Station 8 extensively for nearly all the activity groups. Courting, feeding and nesting were particularly heavy. What loafing that was recorded was found mainly on muskrat houses and included resting of birds on the open water areas.

Appendix Table 16 (cont.)

Nesting Activities: (June 1-July 5)

Individual nesting data

Nest No.	Species	Outcome		Cause of Failure	Vegetative Type of Nest
		Success	Failure		
1	Mallard	X			*Scirpus olneyi*
2	Mallard	X			" "
3	Pintail	X			" "
4	Mallard	X			" "
5	Redhead		X	Dump	*Scirpus acutus*
6	Redhead	X			*Scirpus olneyi*
7	Shoveler	X			" "
8	Coot	X			" "
9	Coot	X			" "
10	Coot		X	Desertion	*Typha sps.*
11	Cin. Teal	X			*Scirpus olneyi*
12	Mallard	X			" "
13	Mallard		X	Predation	" "
14	Coot	X			" "
15	Coot	X			" "
16	Coot		X	Unknown	" "
17	Coot	X			*Scirpus acutus*
18	Cin. Teal	X			*Scirpus olneyi*
19	Coot	X			" "
20	Coot	X			*Distichlis spicata*
21	Redhead	X			*Scirpus olneyi*
22	Coot	X			*Distichlis spicata*
23	Coot	X			*Scirpus acutus*
24	Cin. Teal		X	Unknown	" "
25	Redhead		X	Dump	*Scirpus olneyi*
26	Coot	X			*Distichlis spicata*
27	Mallard	X			*Scirpus olneyi*
28	Coot	X			" "
29	Pintail	X			*Scirpus olneyi*
30	Redhead	X			" "
31	Shoveler	X			" "
32	Coot	X			*Distichlis spicata*
33	Cin. Teal	X			*Scirpus olneyi*
34	Pintail	X			" "
35	Mallard		X	Flooded	" "
36	Redhead	X			" "
37	Cin. Teal	X			*Scirpus acutus*
38	Shoveler	X			*Scirpus olneyi*
39	Shoveler	X			" "
40	Pintail	X			" "
41	Cin. Teal	X			" "
42	Redhead		X	Unknown	*Typha sp.*
43	Gadwall	X			*Scirpus olneyi*

Appendix Table 16 (cont.)

Nest No.	Species	Outcome Success	Outcome Failure	Cause of Failure	Vegetative Type of Nest
44	Redhead	X			*Scirpus olneyi*
45	Ruddy	X			" "
46	Mallard	X			" "
47	Redhead	X			" "
48	Pintail	X			" "
49	Cin. Teal	X			" "
50	Redhead		X	Dump	*Typha sp.*
51	Cin. Teal	X			*Scirpus olneyi*
52	Pintail	X			" "
53	Cin. Teal	X			" "
54	Ruddy	X			" "
55	Gadwall	X			*Distichlis spicata*
56	Ruddy	X			*Scirpus olneyi*
57	Shoveler	X			" "
58	Redhead	X			" "

Nesting Mortality

Ducks

44 Total nests
7 Nests lost

Mortality rate 7/44 x 100 = 16%
Nesting success = 84%

Coots

14 Total nests
2 Nests lost

Mortality rate 2/14 x 100 = 15%
Nesting success = 85%

Nesting Productivity

Size of area--approximately 6.5 acres

Total nesting attempts:
Ducks--44
Coots--14

Total successful nests:
Ducks--37
Coots--12

Nesting attempts/acre:
Ducks--6.8 nests/acre
Coots--2.2 nests/acre

Area productivity:
Ducks--5.7 successful nests/acre
Coots--1.9 successful nests/acre

Brood Rearing: (July 6-August 25)

Some 20 broods of six species were seen during the course of the study. Cover vegetation and food plants were in abundance. *Lemna minor*, *Potamogetons* and many emergent seed bearers were quite numberous.

Broods:

Species	Number of broods	Average brood size
Mallard	4	7

Appendix Table 16 (cont.)

Species	Number of broods	Average brood size
Cinnamon Teal	3	6
Redhead	3	7
Pintail	2	5
Shoveler	2	5
Ruddy	6	8

Sampling Station 8 was given a good rating for brood rearing activities.

Sampling Station 8 Vegetation and Water Conditions

Vegetation type--Mixed: *Scirpus sps.*, & *Typha sps.*

Species compositon:	Percent of total
Scirpus olneyi	80%
Typha sp.	10
Scirpus acutus	5
Distichlis spicata	2
Scirpus paludosus	2
Traces:	1
Sparganium eurycarpum	
Mimulus guttatus	
Eleocharis macrostachya	
Eleocharis acicularia	100%

Area Cover Percentages:

Surface exposure	Percent of total
Vegetation	78%
Open water	22
Bare ground	0
	100%

Water coverage--flooding--99%

Water stability

Determination of water fluctuation on Sampling Station 8 was not made during the study. It was noted that flooding was only a minor cause of nesting mortality. The vegetation was heavy enough that the majority of the nests were constructed well above water level.

Area Rating

All activities except loafing were given a good or excellent rating. Extensive courting and feeding activities were observed during the study. The nesting density was fairly high at 6.1 nestings per acre. The area productivity also was good in that some five broods per acre were brought off successfully. The attraction to brooding hens also appeared good. The overall rating for waterfowl activities was excellent.

Appendix Table 16 (cont.)

Sampling Station 9

Prenesting and General Utilization: (April 25-August 20)

Species	Courting	Feeding	Loafing	Nesting	Brood rear
		Activities			
Mallard	8	11	10	3	2
Pintail	5	10	5	1	3
Redhead	5	22	11	2	4
Gadwall	0	4	3	0	0
Ruddy	0	1	0	0	1
Shoveler	0	9	4	0	0
Cin. Teal	7	10	4	2	0
TOTALS	25	67	37	8	14

Information above is from 16 different observations.

Sampling Station 9 showed attraction to courting birds. Courting parties of four species were seen during the course of the study. A total of 25 birds were recorded participating in courting activities. There were also ducks participating in the other categories. Feeding by ducks was quite evident and occurred mainly in the small open water areas found throughout the study area. Loafing occurred throughout the study and took place mainly on muskrat houses and some on shore line areas. Nesting was also found but not too extensive. Depth of the water seemed to be the controlling factor. This area did prove attractive to brooding birds in that 17 hens of 5 species were recorded with broods during the study. Good cover and available food seemed to be the most important factors.

Nesting Activities: (June 1-July 5)

Individual nesting data

Nest No.	Species	Outcome Success	 Failure	Cause of Failure	Vegetative Type of Nest
1	Coot	X			Scirpus olneyi
2	Coot	X			" "
3	Coot	X			" "
4	Mallard	X			" "
5	Pintail	X			" "
6	Coot		X	desertion	" "
7	Redhead		X	desertion	" "
8	Coot		X	flooding	" "
9	Coot	X			Scirpus acutus
10	Coot	X			" "
11	Coot		X	flooding	Scirpus olneyi
12	Coot	X			Scirpus paludosus
13	Mallard		X	unknown	Scirpus olneyi
14	Coot	X			Scirpus acutus
15	Coot	X			Scirpus olneyi
16	Redhead		X	desertion	" "

Appendix Table 16 (cont.)

Nest No.	Species	Outcome Success	 Failure	Cause of Failure	Vegetative Type of Nest
17	Coot	X			*Scirpus olneyi*
18	Coot		X	unknown	*Scirpus acutus*
19	Mallard	X			" "
20	Coot	X			*Scirpus olneyi*
21	Cin. Teal		X	flooding	Mixed Grasses
22	Coot	X			*Scirpus olneyi*
23	Coot	X			" "
24	Coot		X	unknown	" "
25	Coot	X			" "
26	Coot	X			" "
27	Coot	X			" "
28	Coot	X			" "
29	Coot	X			" "
30	Coot		X	unknown	" "
31	Coot	X			" "
32	Coot	X			Mixed Grasses
33	Cin. Teal	X			*Scirpus olneyi*

Nesting Mortality

Ducks

8 Total nests
4 Nests lost

Mortality rate 4/8 x 100 = 50%
Nesting success = 50%

Coots

25 Total nests
6 Nests lost

Mortality rate 6/25 x 100 = 24%
Nesting success = 76%

Nesting Productivity

Size of area--approximately 3.9 acres

Total nesting attempts:
Ducks- -8
Coots- 25

Total successful nests:
Ducks--4
Coots--19

Nesting attempts/acre:
Ducks--2 nests/acre
Coots--6.4 nests/acre

Area productivity:
Ducks--1.02 successful nests/acre
Coots--4.9 successful nests/acre

Brood Rearing: (July 6-August 25)

Some 14 broods of five species were seen during the study. The area did offer excellent cover for broods and the abundance of *Lemna minor*, and fair growths of *Potamogeton pectinatus* and other attractive food plants offered fair amounts and variety of feeds for the young ducklings.

Appendix Table 16 (cont.)

Broods:

Species	No. of broods	Average brood size
Mallard	2	5
Cin. Teal	4	6
Pintail	3	5
Redhead	4	7
Ruddy	1	9

Sampling Station 9 Vegetation and Water Conditions

Vegetation type--Mixed: *Scirpus olneyi* dominant.

Species composition:	Percent of total
Scirpus olneyi	60%
Distichlis spicata	35
Scirpus paludosus	2
Traces:	3
Scirpus acutus	
Eleocharis macrostachya	
Eleocharis acicularis	
Atriplex patula	
Polypogon monspleliensis	
Hordeum jubatum	
Rumex crispus	
	100%

Area Cover Percentages:

Surface exposure	Percent of total
Vegetation	50%
Open water	40
Bare ground	10
	100%

Water coverage--flooding--80%

Water stability

Water conditions remained somewhat constant. The only flooding which occurred was found in two Coot nestings and one cinnamon teal nest. The vegetation was such that the percentage of water coverage and the slight fluctuation found during the season did not have much affect on nesting activities.

Area Rating

Waterfowl participated in all recorded activities on Sampling Station 9. None of the categories had an excessive amount of usage, but there was enough activity to merit a fair rating for all activities. The conditions seemed to favor coot activities more than ducks. The area would be given a good rating for coots and an overall rating of fair for general waterfowl activities.

Appendix Table 16 (cont.)

Sampling Station 10

Prenesting and General Utilization: (April 25-August 20)

	Activities				
Species	Courting	Feeding	Loafing	Nesting	Brood rear
Cin. Teal	3	2	4	2	0
Gadwall	0	0	2	0	0
Redhead	4	7	5	0	0
Shoveler	0	0	4	0	0
Mallard	0	0	2	1	0
Pintail	0	0	5	1	0
TOTALS	7	9	22	4	0

Information above is from 16 different observations.

This area had only minor courting activities present. The feeding of ducks in this area appeared to be mainly of redhead species. The area still did not afford much feeding for waterfowl. The main activity observed on this area was that of loafing found in six species.

Nesting Activities: (June 1-July 5)

Individual nesting data

Nest No.	Species	Outcome Success	Outcome Failure	Cause of Failure	Vegetative Type of Nest
1	Cin. Teal		X	flooding	Distichlis spicata
2	Mallard		X	predation	Sarcobatus verm.
3	Pintail	X			Distichlis spicata
4	Cin. Teal		X	desertion	Mixed Grasses
5	Coot	X			Scirpus olneyi
6	Coot	X			" "

Nesting Mortality

Ducks
4 Total nests
3 Nests lost

Mortality rate 3/4 x 100 = 75%
Nesting success = 25%

Coots
2 Total nests
0 Nests lost

Mortality rate 0/2 x 100 = 0%
Nesting success = 100%

Nesting Productivity

Size of area--approximately 1.2 acres

Total nesting attempts:
Ducks--4
Coots--2

Total successful nests:
Ducks--1
Coots--2

Appendix Table 16 (cont.)

Nesting attempts/acre:
Ducks--3.3 nests/acre
Coots--1.6 nests/acre

Area productivity:
Ducks--0.83 successful nests/acre
Coots--1.6 successful nests/acre

Brood Rearing: (July 6-August 20)

There were no broods seen in Sampling Station 10 during the study.

Sampling Station 10 Vegetation and Water Conditions

Species composition:	Percent of total
Distichlis spicata	65%
Scirpus olneyi	25
Sarcobatus vermiculatus	5
Eleocharis macrostachya	1
Scirpus paludosus	1
Traces:	3
Scirpus acutus	
Hordeum brachyantherum	
Salicornia rubra	
Allenrolfia punctata	
Juncus balticus	
Polypogon monspleliensis	
	100%

Area Cover Percentages:

Surface exposure	Percent of total
Vegetation	90%
Open water	5
Bare ground	5
	100%

Water coverage--flooding--50%

Water stability

The water level did fluctuate somewhat during the course of the study. Only one of the three nesting losses was due to flooding. The rise and fall of the water level was of no great consequence in the outcome of waterfowl activities.

Area Rating

Sampling Station 10 showed little attraction to waterfowl in almost all activities. Only 43 ducks of five species were recorded in this area during the entire study. All activities were given a poor rating. The overall rating for Sampling Station 10 is poor due to the lack of feed plants and cover vegetation.

Appendix Table 16 (cont.)

1965 RESULTS OF WATERFOWL SURVEYS ON LARVAL SAMPLING STATIONS
Farmington Bay Waterfowl Management Area

Sampling Station 2

Prenesting and General Utilization: (April 27-August 20)

			Activities		
Species	Courting	Feeding	Loafing	Nesting	Brood rear
Cin. Teal	0	1	0	0	0
Mallard	0	2	0	1	0
Redhead	0	5	0	1	0
TOTALS	0	8	0	2	0

Information above is from 16 different observations.

Sampling Station 2 was extremely small and it is felt that a good representation of the vegetation and water type was not available. Only ten ducks were seen in the area in twelve observations. The vegetation and available food was of the type utilized by waterfowl but the entire area was under water.

Nesting Activities (June 1-July 5)

Individual nesting data

		Outcome			Vegetative
Nest No.	Species	Success	Failure	Failure	Type of Nest
1	Coot	X			*Scirpus paludosus*
2	Mallard	X			*Scirpus paludosus*
3	Redhead		X	flooding	*Distichilis spicata*

Nesting Mortality

Ducks

2 Total nests	Mortality rate 1/2 x 100 = 50%
1 Nest lost	Nesting success = 50%

Coots

1 Total nest	Mortality rate 0/1 x 100 = 0%
0 Nests lost	Nesting success = 100%

Nesting Productivity

Size of area--approximately 0.5 acres

Total nesting attempts:	Total successful nests:
Ducks--2	Ducks--1
Coots--1	Coots--1

Appendix Table 16 (cont.)

Nesting Attempts/acre:
  Ducks-- 4 nests/acre
  Coots-- 2 nests/acre

Area Productivity
  Ducks-- 2 successful nests/acre
  Coots-- 2 successful nests/acre

AREA 2 VEGETATION AND WATER CONDITIONS

Vegetation type -- *Scirpus paludosus* (Alkali Bulrush)

Species Composition	Percent of Total
Scirpus paludosus	77%
Distichilis spicata var. *stricta*	10%
Eliocharis macrostachya	8%
Traces:	5%
Typha sp.	
Atriplex patula	
Rumex crispus	
Eliocharis acicularis	
Mimulus guttatus	
	100%

Area Cover Percentages	Percent of Total
Vegetation	80%
Open Water	20%
Bare Ground	0%
	100%

Water Coverage-- Flooding - 100%

Water Stability

Area 2 remained flooded throughout the course of the study. Water levels were not recorded during the study

Area Rating

Area 2 cannot be given a rating accurately as a waterfowl area due to the small size. It does appear that with the conditions present; small vegetation and extensive flooding, this area would not present much attraction to waterfowl.

Appendix Table 16 (cont.)

Sampling Station 6

Prenesting and General Utilization April -- August 20

	Activities				
Species	Courting	Feeding	Loafing	Nesting	Brood Rear
Red Head	0	8	6	0	0
Mallard	0	3	0	0	0
Cin. Teal	0	4	2	0	0
Gadwall	0	3	0	0	0
Totals	0	18	8	0	0

Information above is from 12 different observations (April-Aug.20)

This area offered little in the way of waterfowl activities. Courting, nesting and brood rearing were not participated in at all. Feeding and loafing also were minor.

Nesting Activities

No nests were recorded on the area.

Brood Rearing Activities

No broods were seen on this area.

Station 6 Vegetation and Water Conditions

Vegetation type -- *Typha* sp.

Species Composition:	Percent of total
Typha sp.	98%
Traces:	2%
Scirpus olneyi	
Scirpus acutus	
Sparganium eurycarpum	
	100%

Station Cover Percentages:

Surface Exposure	Percent of total
Vegetation	90%
Open water	10%
Bare ground	0%
	100%

Water coverage--flooding--100%

Station remained covered by water throughout the entire season.

Station Rating

There was very little waterfowl activity on this area. Dense vegetation and deep water were contributing factors to no utilization. Station 6 received a POOR rating for waterfowl utilization.

Appendix Table 16 (cont.)

Sampling Station 7

Prenesting and General Utilization: (April 25-August 20)

Species	Courting	Feeding	Loafing	Nesting	Brood rear
Pintail	3	6	15	3	1
Cin. Teal	23	15	45	12	0
Mallard	4	19	10	3	0
Ruddy	19	7	5	2	4
Gadwall	0	10	9	3	0
Redhead	10	3	10	10	2
Blue Wing Teal	4	3	1	1	0
Shoveler	0	2	4	2	1
TOTALS	63	65	99	36	8

Information above is from 16 different observations.

All classes of activity were observed on this area. Brood rearing was the activity least participated in. Nesting was good, loafing was good and courting and feeding were fair. Courting and feeding were not as extensive due to the lack of open water areas.

Nesting Activities: (June 1-July 5)

Individual nesting data

Nest No.	Species	Outcome Success	Outcome Failure	Cause of Failure	Vegetative Type of Nest
1	Mallard	X			*Distichilis spicata*
2	Coot	X			*Scirpus paludosus*
3	Mallard	X			*Scirpus paludosus*
4	Pintail	X			*Distichilis spicata*
5	Redhead	X			*Distichilis spicata*
6	Redhead		X	unknown	*Scirpus paludosus*
7	Mallard	X			*Scirpus paludosus*
8	Shoveler	X			*Scirpus paludosus*
9	Redhead	X			*Scirpus paludosus*
10	Cin. Teal	X			*Distichilis spicata*
11	Coot	X			*Distichilis spicata*
12	Coot	X			*Scirpus olneyi*
13	Redhead		X	Dump	*Distichilis spicata*
14	Redhead	X			*Distichilis spicata*
15	Shoveler	X			*Scirpus paludosus*
16	Cin. Teal	X			*Scirpus paludosus*
17	Redhead	X			*Scirpus paludosus*
18	Cin. Teal	X			*Scirpus paludosus*
19	Redhead		X	flooding	*Distichilis spicata*
20	Cin. Teal	X			*Distichilis spicata*
21	Redhead	X			*Scirpus paludosus*
22	Cin. Teal		X	predation	*Scirpus paludosus*

Appendix Table 16 (continued)

Nest No.	Species	Outcome Success	 Failure	Cause of Failure	Vegetative Type of Nest
23	Cin. Teal	X			*Scirpus paludosus*
24	Pintail		X	predation	Mixed Grasses
25	Cin. Teal	X			*Scirpus olneyi*
26	Gadwall	X			*Scirpus paludosus*
27	Redhead	X		dump	*Distichilis spicata*
28	Pintail	X			*Scirpus paludosus*
29	Mallard	X			*Scirpus olneyi*
30	Coot	X			*Distichilis spicata*
31	Gadwall	X			*Distichilis spicata*
32	Coot	X			*Scirpus paludosus*
33	Cin. Teal		X	desertion	*Distichilis spicata*
34	Redhead	X			*Distichilis spicata*
35	Gadwall	X			*Distichilis spicata*
36	Blue Wing Teal	X			*Scirpus paludosus*
37	Cin. Teal		X	desertion	*Scirpus paludosus*
38	Cin. Teal	X			*Distichilis spicata*
39	Cin. Teal	X			*Distichilis spicata*
40	Cin. Teal	X			*Distichilis spicata*
41	Ruddy	X			*Scirpus paludosus*
42	Ruddy	X			*Scirpus paludosus*

Nesting Mortality

Ducks

37 Total nests	Mortality rate 7/37 x 100 = 18.9%
7 Nests lost	Nesting success = 81.1%

Coots

5 Total nests	Mortality rate 0/5 x 100 = 0%
0 Nests lost	Nesting success = 100%

Nesting Productivity

Size of area - approximately 5.4 acres

Total nesting attempts:
Ducks--37
Coots-- 5

Total successful nests:
Ducks--30
Coots-- 5

Nesting attempts/acre:
Ducks-- 5.85 nests/acre
Coots-- 0.93 nests/acre

Area productivity:
Ducks-- 5.55 successful nests/acre
Coots-- 0.93 successful nests/acre

Brood Rearing:

Eight broods were seen on this area during the study. Four species were participating in brood-rearing activities. The water and vegetation were not such that brooding hens were attracted.

Appendix Table 16 (cont.)

Broods:

Species	No. of broods	Average brood size
Pintail	1	5
Ruddy	4	8
Redhead	2	5
Shoveler	1	6

Sampling Station 7 was given a fair rating for brood-rearing activities.

Sampling Station 7 Vegetative and Water Conditions

Vegetation type--Mixed: Distichilis spicata, and Scirpus paludosus.

Species composition:	Percent of total
Distichilis spicata var. stricta	50%
Scirpus paludosus	35
Hordeum jubatum	3
Salicornia rubra	2
Traces:	10
Puccinelia distans	
Rumex crispus	
Tamarix gallica	
Eliocharis macrostachya	
Atriplex patula	
Polypogon monspeliensis	
Allenrolfia sp.	
Typha sp.	
Scirpus olneyi	
	100%

Area Cover Percentages:

Surface exposure	Percent of total
Vegetation	70%
Open water	10%
Bare ground	20%
	100%

Water coverage--flooding--14%

Water stability

Water conditions remained constant on Sampling Station 7. There was no flooding to speak of. There were small waterways which meandered through the area, but the water did not cover any appreciable amount of the surface.

Appendix Table 16 (cont.)

Area Rating

Sampling Station 7 was rated very good for waterfowl activities. Nesting productivity was especially good. Loafing, courting and feeding activities were also observed, but not as extensive as had been expected. Brooding was not too extensive on the area due to the expansive water area just on the south side of the dike adjacent to the area. The overall rating for this area was very good.

Sampling Station 8

Prenesting and General Utilization: (April 25--August 20)

Species	Courting	Feeding	Loafing	Nesting	Brood rear
Redhead	10	31	11	1	1
Gadwall	0	13	2	0	0
Pintail	0	20	9	0	2
Shoveler	2	2	5	0	0
Mallard	0	7	0	0	0
Cin. Teal	0	15	5	3	2
TOTALS	12	88	32	4	5

Information above is from 16 different observations.

Early in the season Sampling Station 8 suported a considerable amount of waterfowl feeding and loafing. As the season progressed, much of the water had disappeared and waterfowl activities were negligible.

Nesting Activities: (June 1-July 5)

Individual nesting data

Nest No.	Species	Outcome		Cause of Failure	Vegetative Type of Nest
		Success	Failure		
1	Coot	X			Scirpus paludosus
2	Redhead	X			Typha sp.
3	Coot		X	desertion	Distichilis spicata
4	Coot	X			Distichilis spicata
5	Cin. Teal		X	desertion	Distichilis spicata
6	Cin. Teal	X			Scirpus paludosus
7	Cin. Teal	X			Typha sp.

Nesting Mortality

Ducks

4 Total nests
1 Nest lost

Mortality rate 1/4 x 100 = 25%
Nesting success = 75%

Appendix Table 16 (cont.)

Coots
3 Total nests
1 Nest lost

Mortality rate 1/3 x 100 = 33%
Nesting success = 67%

Nesting Productivity

Size of area--approximately 5.5 acres

Total nesting attempts:
Ducks--4
Coots--3

Total successful nests:
Ducks--3
Coots--2

Nesting attempts/acre
Ducks--0.72 nests/acre
Coots--0.55 nests/acre

Area productivity:
Ducks--0.72 successful nests/acre
Coots--0.36 successful nests/acre

Brood Rearing: (July 6-August 25)

Only five broods were found on Sampling Station 8. Shortly after the brooding activities began, this area became dry and barren. Those broods which were observed moved into areas of greater water and cover.

Broods:

Species	No. of broods	Average brood size
Redhead	1	8
Pintail	2	5
Cin. Teal	2	5

Sampling Station 8 was given a poor rating for brood rearing activities in that brooding hens did not stay in the area.

Sampling Station 6 Vegetation and Water Conditions

Vegetation type--Distichilis spicata

Species composition:	Percent of total
Distichilis spicata	70%
Scirpus paludosus	15
Hordeum jubatum	5
Typha sp.	5
Traces:	5
Eleocharis macrostachya	
Polypogon monspeliensis	
Salicornia rubra	
Allenrolfia punctata	
Scirpus acutus	
	100%

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Appendix Table 16 (cont.)

Area Cover Percentages:

Surface exposure	Percent of total
Vegetation	50%
Open water	10
Bare ground	40
	100%

Water coverage--flooding--10%

Water stability

At the beginning of the study some 40% of the area was covered with water. As the season progressed, the water diminished until shortly after the first broods were seen. At this time the entire area, except one small flow of water through the area, was dry.

Area Rating

Sampling Station 8 was given a poor rating for courting, nesting and brood rearing activities. It should be given a fair rating for feeding and loafing early in the season. Late in the season there was literally no waterfowl activity. The overall rating for this area was poor.

Sampling Station 10

Prenesting and General Utilization: (April 25-August 20)

		Activities			
Species	Courting	Feeding	Loafing	Nesting	Brood rear
Shoveler	0	11	3	0	0
Pintail	0	8	5	0	1
Redhead	0	7	5	0	0
Ruddy	7	5	0	0	0
Cin. Teal	10	5	5	1	0
Gadwall	0	0	1	2	0
Mallard	4	6	3	1	0
TOTALS	21	42	22	4	1

Information above is from 16 different observations.

There was little waterfowl activity on Sampling Station 10. More birds participated in feeding activities than in the other categories. The entire area, during the nesting season had a coverage of water. Nesting was not of any consequence.

Nesting Activities: (June 1-July 5)

Individual nesting data

Appendix Table 16 (cont.)

Nest No.	Species	Outcome Success	 Failure	Cause of Failure	Vegetative Type of Nest
1	Coot	X			*Typha sp.*
2	Gadwall		X	flooding	*Distichilis spicata*
3	Coot	X			*Distichilis spicata*
4	Mallard	X			*Scirpus olneyi*
5	Cin. Teal	X			*Scirpus paludosus*
6	Coot		X	unknown	*Distichilis spicata*
7	Cin. Teal		X	desertion	*Distichilis spicata*

Nesting Mortality

Ducks
4 Total nests
2 Nests lost
Mortality rate 2/4 x 100 = 50%
Nesting success = 50%

Coots
3 Total nests
1 Nests lost
Mortality rate 1/3 x 100 = 33%
Nesting success = 67%

Nesting Productivity

Size of area--approximately 8.2 acres

Total nesting attempts:
Ducks--4
Coots--3

Total successful nests:
Ducks--2
Coots--2

Nesting attempts/acre:
Ducks--0.43 nests/acre
Coots--0.36 nests/acre

Area productivity:
Ducks--0.24 successful nests/acre
Coots--0.24 successful nests/acre

Brood Rearing: (July 6-August 20)

Only one brood was seen on Sampling Station 10 during the study. It was a pintail brood of seven ducklings. This area had little attraction to brooding hens. The area would be given a poor rating for brood rearing activities.

Sampling Station 10 Vegetation and Water Conditions

Vegetation type--Mixed: *Distichilis spicata*, *Scirpus sp.*, *Typha sp.*

Species composition:	Percent of total
Distichilis spicata var. *stricta*	48%
Scirpus paludosus	36
Typha sp.	12
Traces:	4
Hordeum jubatum	
Scirpus olneyi	
Scirpus acutus	
	100%

Appendix Table 16 (continued)

Area Cover Percentages:

Surface exposure	Percent of total
Vegetation	85%
Open water	15%
Bare ground	0%
	100%

Water coverage--flooding -- 100%

Water stability

This area remained flooded throughout the entire study. There was a continual rise of the water level during the nesting season. Only the more robust species such as *Scirpus acutus* and *Scirpus olneyi* could offer nesting conditions. These constituted a minor percentage of the total vegetation.

Area Rating

All activities received a poor rating for the area. There was some feeding early in the season, which was the activity most participated in. It was, nevertheless, of little significance. The overall rating for Sampling Station 10 would be poor.

Sampling Station 14

Prenesting and General Utilization: (April 25 - August 20)

	Activities				
Species	Courting	Feeding	Loafing	Nesting	Brood rear
Shoveler	0	8	2	0	2
Redhead	0	2	3	3	2
Mallard	2	15	6	4	3
Gadwall	0	15	8	1	3
Pintail	6	4	4	0	7
Ruddy	24	19	0	2	4
Cin. Teal	10	5	0	0	0
Blue Wing Teal	0	0	5	0	0
TOTALS	42	68	28	10	21

Nesting Activities: June 1-July 5)

Individual nesting data

Appendix Table 16 (cont.)

Nest No.	Species	Outcome		Cause of Failure	Vegetative Type of Nest
		Success	Failure		
1	Coot	X			*Scirpus acutus*
2	Coot	X			*Scirpus acutus*
3	Coot	X			*Scirpus acutus*
4	Coot		X	unknown	*Scirpus acutus*
5	Mallard	X			*Scirpus olneyi*
6	Coot	X			*Scirpus olneyi*
7	Coot	X			*Scirpus olneyi*
8	Mallard		X	flooding	*Scirpus acutus*
9	Coot	X			*Scirpus acutus*
10	Redhead		X	dump	*Scirpus acutus*
11	Coot	X			*Typha sp.*
12	Coot	X			*Scirpus acutus*
13	Redhead		X	dump	*Typha sp.*
14	Coot	X			*Typha sp.*
15	Mallard	X			*Typha sp.*
16	Gadwall	X			*Scirpus acutus*
17	Coot	X			*Scirpus acutus*
18	Coot	X			*Scirpus olneyi*
19	Redhead	X			*Scirpus olneyi*
20	Mallard	X			*Scirpus acutus*
21	Coot	X			*Scirpus acutus*
22	Coot	X			*Scirpus acutus*
23	Coot	X			*Scirpus acutus*
24	Coot	X			*Scirpus acutus*
25	Coot		X	unknown	*Typha sp.*
26	Coot	X			*Scirpus olneyi*
27	Coot	X			*Scirpus olneyi*
28	Coot	X			*Scirpus acutus*
29	Coot		X	unknown	*Scirpus acutus*
30	Ruddy	X			*Scirpus olneyi*
31	Ruddy	X			*Scirpus acutus*

Nesting Mortality

Ducks

10 Total nests
3 Nests lost

Mortality rate 3/10 x 100 = 30%
Nesting success =70%

Coots

21 Total nests
3 Nests lost

Mortality rate 3/21 x 100 = 14%
Nesting success = 86%

Nesting Productivity

Size of area--approximately 3.5 acres

Total nesting attempts:
Ducks--10
Coots--21

Total successful nests:
Ducks--7
Coots--18

Appendix Table 16 (cont.)

Nesting attempts/acre	Area productivity:
Ducks--2.8 nests/acre	Ducks--2.0 successful nests/acre
Coots--6.0 nests/acre	Coots--5.1 successful nests/acre

Brood Rearing: (July 5-August 20)

Some 21 broods of six different species were found utilizing this area. The vegetation, both cover and food species, was abundant. Lemna minor was found throughout the area and certain areas were producing good crops of Potamogetons.

Broods:

Species	No. of broods	Average brood size
Shoveler	2	6
Redhead	2	7
Mallard	3	5
Gadwall	3	6
Pintail	7	5
Ruddy	4	8

Sampling Station 14 Vegetation and Water Conditions

Vegetation type--Mixed: Scirpus olneyi, Scirpus acutus, Typha sp.

Species composition:	Percent of total
Scirpus olneyi	50%
Scirpus acutus	34
Typha sp.	16
	100%

Area Cover Percentages:

Surface exposure	Percent of total
Vegetation	40%
Open water	60
Bare ground	0
	100%

Water coverage--flooding--100%

Water stability

Water level did fluctuate somewhat, as there was a rise during the nesting season. As the season progressed water fluctuation tapered off. Flooding was rare as a nesting mortality of ducks. The vegetation was such that nests could be constructed above the rising water.

Area Rating

Sampling Station 14 was given a fair rating for loafing, a good rating for courting, feeding, nesting and a very good rating for brood rearing. This area sustained more activity than had been previously expected. The over all rating for this are was good.

Appendix Table 16 1965 Summary of Nesting Survey

Lake Front Gun, Fur and Reclamation Club

Sampling Station	Nesting Attempts	Successful Nests	Mortality Rate %	Area Productivity Nests/Acre	Principal Vegetation	Area Rating
1	8	2	75	0.33	Distichlis stricta	Poor
2	0	0	0	0	Distichlis stricta	Poor
6	5	3	40	0.88	Distichlis stricta Scirpus olneyi	Fair
7	3	1	67	0.4	Distichlis stricta Scirpus paludosus	Poor
8	40	33	15	5.0	Scirpus olneyi	Excellent
9	8	4	50	2.0	Distichlis stricta Scirpus olneyi	Fair
10	4	1	75	0.83	Distichlis stricta Scirpus olneyi	Poor
Farmington Bay Waterfowl Management Area						
2	2	1	50	2.0	Scirpus paludosus	N.R.
6	0	0	0	0	Typha Sp.	Poor
7	36	28	22.2	5.2	Distichlis stricta Scirpus paludosus	Excellent
8	4	3	25	0.72	Distichlis stricta Scirpus paludosus	Poor
10	4	2	50	.22	Distichlis stricta Scirpus paludosus	Poor
14	10	7	30	2.0	Scirpus olneyi Scirpus acutus	Good

Appendix

Table 17. Summary of Larval Sampling Stations

Sampling Station	Vegetation Type	Water Management Practiced	Mosquito Production Ave. No./Dip				1965 Wildlife Productivity Successful nests/acre	
			1962	1963	1964	1965		
Lake Front Club 1	Salt Grass	Rapid seasonal drawdown	1.16	0.63	0.30	1.31	duck coot	0.33 0
2	Salt Grass	Gradual seasonal drawdown	1.10	0.14	0.02	0.49	duck coot	0 2.8
6	Mixed salt grass and bulrush	Gradual seasonal drawdown	0.82	0.62	0.10	0.52	duck coot	0.88 0.30
7	Mixed salt grass and alkali bulrush	Gradual seasonal drawdown	0.26	0.27	0.42	0.21	duck coot	0.4 2.9
8	Mixed bulrushes	Gradual seasonal drawdown	0.40	0.11	0.07	0.54	duck coot	5.7 1.9
9	Mixed salt grass and Olney's bulrush	Permanent flooding	0.49	0.49	0.29	0.34	duck coot	1.02 4.9
10	Salt grass	Permanent flooding	0.77	0.27	0.02	0.33	duck coot	0.83 1.6
Farmington Bay 2	Alkali bulrush	Gradual seasonal drawdown	0.54	0.04	0.02	0.03	duck coot	2 2
6	Cattail	Gradual seasonal drawdown Permanent flooding, 1965	3.81	1.43	0.01	0.006	duck coot	0 0

Appendix Table 17 (cont.)

Sampling Station	Vegetation Type	Water Management Practiced	Mosquito Production Ave. No./Dip				1965 Wildlife Productivity Successful nests/acre	
			1962	1963	1964	1964		
7	Mixed salt grass and alkali	Flood irrigation	0.91	0.20	0.03	0.46	duck coot	5.55 0.93
8	Mixed salt grass and alkali bulrush	Rapid seasonal drawdown	2.48	2.09	0.50	1.31	duck coot	0.72 0.36
10	Mixed salt grass, bulrushes and cattail	Gradual seasonal drawdown	0.48	0.25	0.22	0.48	duck coot	0.24 0.24
14	Mixed bulrushes and cattail	Permanent flooding	1.76	0.19	0.12	0.05	duck coot	2.0 5.1

Appendix Table 17 (cont.)

Sampling Station	Principal Vegetation Type	Water Management Practiced	Mosquito Production			Wildlife Habitat
			1963	1964	1965	
Wheeler Test Area 1	Grain	None	0	0	0	Stations 1 - 3 are being developed for agriculture
2A		None	0.20	0	0	
2B		None	0.02	0.56	0.78	
3	Salt Grass	None	0.18	0.14	0	
4	Salt Grass Pondweed	None	0.01	0.10	0.02	Stations 4 - 6 are edges of reservoirs. Feeding and loafing activities were observed at these stations
5	Pondweed	None	0	0	0	
6	Salt Grass	None	0.09	0.04	0.16	
7	Salt Grass	None	1.78	0.63	1.58	Little nesting

Appendix Table 17 (cont.)

Sampling Station	Principle Vegetation Type	Water Management Practiced	Mosquito Production			Wildlife Habitat
			1963	1964	1965	
8	Salt Grass	Permanent Flooding	0.56	0.53	0.01	Feeding and loafing
9	Salt Grass	Gradual Seasonal drawdown	0.03	0.43	0.03	Negligible
10	Salt Grass	None	0.96	0.03	0	Feeding and loafing
11	Salt Grass spiker rushes and bulrush	None	0.08	1.65	1.26	Negligible
12	Salt Grass	None	0.54	0.32	1.84	Negligible
13	Some Salt Grass	Permanent Flooding	0	0	0	Feeding and loafing
14	Some Alkali bulrush	Permanent Flooding	0	0.02	0	Feeding and loafing
16	Salt Grass	Permanent withdrawal	1.34	0.421	0.53	Negligible

Appendix Table 18

1961-64 STREAM FLOW DATA

Farmington Creek

Water Year (Oct. to Sept.)	Max. Daily Flow	Highest Month	Min. Daily Flow	Lowest Month	Mean	Acre Feet
1961-62	202	May	0	Oct.	17.4	12,570
1962-63	106	May	1.7	Aug.	10.6	7,700
1963-64	202	May	1.9	Jan.	16.2	11,760
Ricks Creek						
1961-62	22	May	0	Nov.	2.88	2,080
1962-63	12	May	0.4	Jan.	1.83	1,330
1963-64	37	May	0.5	Dec.	3.26	2,360
Parrish Creek						
1961-62	15.8	May	0.21	Sept.	1.89	1,370
1962-63	8.91	May	0.61	Aug.	1.14	826.9
1963-64	19.7	May	0.21	Oct.	2.01	1,460
Centerville Creek						
1961-62	13	May	0.7	Oct.	2.64	1,910
1962-63	8.0	May	0	Aug.	1.80	1,300
1963-64	23	May	0.8	Oct.	3.27	2,370
Stone Creek						
1961-62	39	May	0.2	Sept.	3.77	2,740
1962-63	17	May	0.3	Aug.	2.25	1,630
1963-64	37	May	0	Oct.	3.97	2,880

Mill Creek

Water Year (Oct. to Sept.)	Max. Daily Flow	Highest Month	Min. Daily Flow	Lowest Month	Mean	Acre Feet
1961-62	47	April	0.5	Jan.	7.78	5,630
1962-63	32	May	0	Jan.	4.21	3,050
1963-64	81	May	0.7	Oct.-Jan.	8.62	6,260
Jordan River and Surplus Canal Combined--21st So.*						
1961-62	471	June	117	Jan.	232	168,100
1962-63	511	June	123	Feb.	218	157,900
1963-64	1160	June	143	Jan.	275	199,300
1964-65						
Jordan River--21st So. S.L.C.						
1961-62	147	July	12	March	94.7	68,550
1962-63	213	April	10	Aug.	102	73,640
1963-64	150	March	0	May	92.3	67,020
1964-1965						
Surplus Canal--21st So. S.L.C.						
1961-1962	408	June	19	Jan.	137	99,520
1962-63	435	June	0	Feb.	116	84,230
1963-64	1070	June	4	Feb.	132	132,300
1964-65						

*Salt Lake City

*Unless indicated, all measurements are in cubic feet per second.

Appendix Table 19

1961-1965 WATER FLOW OF STREAMS ENTERING INTO THE STUDY AREAS

Jordan River at 2100 South--Salt Lake City, Utah

1961-1962	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Total cfs	2775	3118	3449	3113	2876	1808	1932	2559	3236	3470	3244	2988
Mean cfs	89.5	104	111	100	103	58.3	64.4	82.5	108	112	105	99.6
Total acre feet	5500	5130	6840	6170	5700	3590	3830	5080	6420	6880	6430	5930
Maximum--147 cfs Minimum--12 cfs Mean--94.7 cfs Total acre feet--68,550												
1962-1963												
Total cfs	3025	2919	3456	4372	4830	3483	3524	2755	2364	2377	2117	1905
Mean cfs	97.6	97.3	111	141	172	112	118	88.9	78.8	76.7	68.3	63.5
Total acre feet	6000	5790	6850	8670	9580	6910	7000	5460	4690	4710	4200	3780
Maximum--213 cfs Minimum--10 cfs Mean--102 cfs Total acre feet--73,640												
1963-1964												
Total cfs	2440	1948	2817	3080	3514	4169	3543	792	2580	2901	2709	3299
Mean cfs	78.7	64.9	90.9	99.4	121	134	110	25.5	86	93.6	87.4	110
Total acre feet	4840	3860	5590	6110	6970	8270	7030	1570	5120	5750	5370	6540
Maximum--150 cfs Minimum--0 cfs Mean--92.3 cfs Total acre feet--67,020												
1964-1965												
Total cfs	3720	3116	2451	3284	2927	3392	2063	2314	3837	4521	4164	3984
Mean cfs	120	104	79.1	106	105	109	68.8	74.6	128	146	134	133
Total acre feet	7380	6180	4860	6510	5810	6730	4090	4590	7610	8970	8260	7900
Maximum--348 cfs Minimum--100 cfs Mean--169 cfs Total acre feet--122,600												

Surplus Canal 2100 South--Salt Lake City, Utah

1961-1962	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Total cfs	2048	2496	1908	1614	2450	4106	4728	7317	7716	5310	4256	6235
Mean cfs	66.1	83.2	61.5	52.1	87.5	132	158	236	257	171	137	208
Total acre feet	4060	4950	3780	3200	4860	8140	9380	14510	15300	10530	8440	12370
Maximum--408 cfs Minimum--19 cfs Mean--137 cfs Total acre feet--99,520												

Appendix Table 19 (cont.)

1961-1965 WATER FLOW OF STREAMS ENTERING INTO THE STUDY AREAS

Surplus Canal 2100 South--Salt Lake City, Utah (continued)

1962-1963	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Total cfs	3802	3086	2278	971	0	1869	2758	4963	8115	3795	4919	5903
Mean cfs	123	103	73.5	31.3	0	60.3	91.4	160	270	122	154	197
Total acre feet	7540	6120	4520	1930	0	3710	5470	9840	16100	7530	9760	11710
Maximum--435 cfs Minimum--0 cfs Mean-116 cfs Total acre feet--84,230												
1963-1964												
Total cfs	4706	3856	2857	2358	1694	1896	2808	14388	15846	4765	6004	5516
Mean cfs	152	124	92.2	76.1	58.4	61.2	93.6	464	528	154	194	184
Total acre feet	9330	7650	5670	4680	3360	3760	5570	28540	31430	9450	11910	10940
Maximum--1070 cfs Minimum--4 cfs Mean--182 cfs Total acre feet--132,300												
1964-1965												
Total cfs	3796	3352	5012	4421	4249	3464	5158	10781	16924	8191	7595	8185
Mean cfs	122	112	162	143	152	112	172	348	564	264	245	273
Total acre feet	7530	6650	9940	8770	8430	6870	10230	21380	33570	16250	15060	16230
Maximum--970 cfs Minimum--85 cfs Mean--222 cfs Total acre feet--160,900												

Jordan River Below Cudahy Lane, Salt Lake County

1963-1964	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Total cfs	2699	2718	2866	3092	3264	4043	4151	6891	5567	3450	2840	3702
Mean cfs	87.1	90.6	92.5	99.7	113	130	138	222	186	111	91.6	123
Total acre feet	5350	5390	5680	6130	6470	8020	8230	13670	11040	6850	5630	7340
Maximum--294 cfs Minimum--71 cfs Mean--124 cfs Total acre feet--89,800												
1964-1965												
Total cfs	3827	3509	4139	4267	3826	4396	6202	7303	7953	5661	5490	5225
Mean cfs	123	117	134	138	137	142	207	236	265	183	177	174
Total acre feet	7590	6960	8210	8460	7590	8720	12300	14490	15770	11230	10890	10360
Maximum--348 cfs Minimum--100 cfs Mean--169 cfs Total acre feet--122,600												

Appendix Table 19 (cont.)

1961-1965 WATER FLOW OF STREAMS ENTERING INTO THE STUDY AREAS

Surplus Canal at Cohn's Slough, Salt Lake County

1963-1964	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Total cfs	4294	3963	2988	2354	1671	1863	2534	8320	7549	2981	2485	3592
Mean cfs	139	132	96.4	75.9	57.6	60	84.5	268	252	96.2	80.2	120
Total acre feet	8520	7860	5930	4670	3310	3700	5030	16500	14970	5910	4930	7120

Maximum--600 cfs Minimum--16 cfs Mean--122 cfs Total acre feet--88,450

1964-1965												
Total cfs	2872	1769	4915	4354	4106	3421	4151	4775	7410	4922	4413	5461
Mean cfs	92.6	59	159	140	147	110	138	154	247	159	142	182
Total acre feet	5700	3510	9749	8640	8140	6790	8230	9470	14700	9760	8753	10800

Maximum--515 cfs Minimum--20 cfs Mean--144 cfs Total acre feet--104,300

North Point Canal--Highway 40, Salt Lake City, Utah

1963-1964	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Total cfs	705	0	0	0	0	0	107	763	480	1319	1054	1143
Mean cfs	22.7	0	0	0	0	0	3.6	24.6	16	42.5	34	38.1
Total acre feet	1400	0	0	0	0	0	212	1510	952	2600	2090	2270

Maximum--71 cfs Minimum--0 cfs Mean--15.2 cfs Total acre feet--11,030

1964-1965												
Total cfs	707	1316	56	0	0	0	109	1402	1228	1494	1050	696
Mean cfs	22.8	43.9	1.8	0	0	0	3.6	45.2	40.9	48.2	33.9	23.2
Total acre feet	1400	2610	111	0	0	0	216	2780	2440	2960	2080	1380

Maximum--70 cfs Minimum--0 cfs Mean--22.1 cfs Total acre feet--15,980

Appendix Table 19 (cont.)

1961-1965 WATER FLOW OF STREAMS ENTERING INTO THE STUDY AREAS

Goggin Drain near Magna Utah

1963-1964	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Total cfs	115	57	26	19	21	83	259	5964	8604	573	2321	736
Mean cfs	3.7	1.9	0.9	0.6	0.7	2.7	8.6	192	286	18.5	74.9	25
Total acre feet	228	114	52	37	42	164	513	11830	17070	1140	4600	1460
Maximum--398 cfs Minimum--0 cfs Mean--51 cfs Total acre feet--37,250												
1964-1965												
Total cfs	275	517	249	167	171	65	1012	3352	8365	2299	2635	1696
Mean cfs	8.9	17.2	8.04	5.4	5.9	2.1	33.7	108	279	74.2	85	56.5
Total acre feet	544	1030	494	331	339	129	2010	6650	16590	4560	5230	3360
Maximum--438 cfs Minimum--1.3 cfs Mean--57 cfs Total acre feet--41,270												

cfs = cubic feet per second

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Appendix Table 20

DEFINITIONS OF CLASS "C" AND CLASS "D" WATERS

Class "C" Waters shall be so protected against pollution as to be suitable at all times for domestic water supplies which are treated before use by coagulation, sedimentation, filtration, and disinfection. Class "C" waters shall be suitable without treatment for irrigation, stock watering, fish and wildlife propagation, recreation (except swimming), as a source for industrial supplies, and for other uses as may be determined by the Utah Water Pollution Board.

No person shall discharge into Class "C" waters any wastes

(1) which result in chemical characteristics of said waters exceeding the limits prescribed by "Public Health Service Drinking Water Standards, 1962," or

(2) which result in chemical characteristics of said waters exceeding the recommendations for irrigation water quality as outlined in Chapter 5 of the U. S. Department of Agriculture "Agricultural Handbook No. 60," issued February, 1954, or

(3) which result in a monthly arithmetical average "most probable number (MPN) of coliform organisms in said waters exceeding 5,000 per 100 milliliters; or in an MPN exceeding this number in more than 20% of the samples collected during any month; or in an MPN exceeding 20,000 per 100 milliliters in more than 5% of such samples, or

(4) which result in a monthly arithmetical average biochemical oxygen demand (BOD) in said waters exceeding 5 milligrams per liter (mg/l); or in a BOD exceeding this amount in more than 20% of the samples collected in any month; or in a BOD exceeding 10 mg/l in more than 5% of such samples, or

(5) which result in any slicks, floating solids, suspended solids or sludge deposits in said waters which are readily visible, or which result in appreciable change in color of said waters, or

(6) which result in a pH of said waters lower than 6.5 or greater than 9.0, or

(7) which contain any toxic wastes, phenols, or other deleterious substances in such concentrations or at such temperatures as will render said waters injurious to fish life and waterfowl, or unsafe or unsuitable as sources of water supply for domestic use, food processing or industrial use, or unsuitable for agricultural purposes, stock watering, or recreation.

Class "D" Waters shall be so protected against pollution as to be suitable at all times for limited irrigation, not including irrigation of lawns, recreational areas, pastures used for dairy cattle, root crops, or any low growing crops produced for human consumption. Such waters shall be suitable also as a source for industrial supplies and for other uses as may be determined by the Utah Water Pollution Board.

Appendix Table 20 (cont.)

No person shall discharge into Class "D" waters any wastes

(1) which result in chemical characteristics of said waters exceeding the limits prescribed by "Public Health Service Drinking Water Standards, 1962" or

(2) which result in chemical characteristics of said waters exceeding the recommendations for irrigation water quality as outline in Chapter 5 of the U. S. Department of Agriculture "Agricultural Handbook No. 60," issued February, 1954, or

(3) which result in a monthly arithmetical average "most probable number" (MPN) of coliform organisms in said waters exceeding 5,000 per 100 milliliters; or in an MPN exceeding this number in more than 20% of samples collected during any month; or in an MPN exceeding 20,000 per 100 milliliters in more than 5% of such samples, or

(4) which result in a monthly arithmetical average biochemical oxygen demand (BOD) in said waters exceeding 25 milligrams per liter (mg/l); or in a BOD exceeding this amount in more than 20% of the samples collected in any month; or in a BOD exceeding 50 mg/l in more than 5% of such samples, or

(5) which result in any slicks, floating solids, suspended solids or sludge deposits in said waters which are readily visible, or which result in an appreciable change in color of said waters, or

(6) which result in a pH of said waters lower than 6.5 or greater than 9.0, or

(7) which contain any toxic wastes, phenols, or other deleterious substances in such concentrations or at such temperatures as will render said waters unsuitable for the uses designated for Class "D" waters above.

These definitions are from Utah State Department of Health Waste Disposal Regulations.

Appendix Table 21

SUMMARY OF ELECTRICAL CONDUCTIVITY MEASUREMENTS

Area	Maximum		Minimum	
	Measurement	Month	Measurement	Month
Jordan River 21st South Salt Lake City	2,100	Aug.	1,630	April
Cudahy Lane	2,050	March	444	June
Farmington Bay Waterfowl Management Area	3,230	June	one measurement only	
Surplus Canal Cohen Flume	2,140	Jan.	603	June
Lake Front Gun, Fur and Reclamation Club				
Station 1	6,500	Sept.	1,100	June
Station 2	2,600	Sept.*	970	June
Station 3	2,800	Sept.	1,080	July
Station 4	3,600	Sept.	900	June
Station 5	3,800	April	1,050	June
Wheeler Machinery Company Test Area				
Station 1	960	April	330	June
Station 2	910	April	480	May
Station 3	560	July	100	May
Station 4	1,100	May	300	May

*April also had a maximum of 2,600 at this station.

Appendix Table 22 (cont.)

1963-1964 WATER QUALITY DATA

Area	5 Day BOD mg/L		pH		MPN Coliform Organisms/100 ml.	
	High	Low	High	Low	High	Low
South Davis County Sewer Improvement District South Plant	46	21	-	-	43,000,000	230,000
South Davis County Sewer Improvement District North Plant	33	25	-	-	43,000,000	430,000
Farmington Bay Waterfowl Management Area - South End	8.6	2.9	7.9	7.55	230,000+	23
Farmington Bay Waterfowl Management Area - North End	8.1	1	9.4	8.55	4,300	23
Surplus Canal - Cohn's Slough	4.9	2.7	7.55	7	230,000	*
Lake Front Gun Fur & Reclamation Club - Marsh Pond	12	1	9.35	7.7	930	4
Wheeler Machinery Company Reservoir	2.6	1.2	9.65	7.6	1,500	75

*One Measurement Only

Appendix Table 23

1963-64 SUMMARY OF CHEMICAL QUALITY WATER ANALYSIS IN THE STUDY AREAS

(Analysis by the Soil Conservation Service)

Lake Front Gun, Fur and Reclamation Club

Sampling Station	Calcium	Magnesium	Sodium	Potassium	Chloride	Sulfate	Bicarbonate	Conductivity in micromohos at 25°C	Total dissolved solids %	Sodium Absorption Ratio	Class*
1 Mean of 5 samples	5.7	7.04	22.12	1.01	21.06	11.04	4.5	3497	0.23	5.4	C_4-S_2
Maximum	7.94	11.38	37.5	1.31	36	16.32	6.46	5490	0.36	12	C_4-S_4
2 Mean of 5 samples	5.7	6.23	12.3	0.63	11.7	8.54	3.87	2266	0.12	5.04	C_4-S_2
Maximum	6.03	7.42	16.8	0.82	16	10.46	4.9	2810	0.18	6.9	C_4-S_3
3 Mean of 5 samples	5.64	8.06	19.7	0.91	18.52	11.08	3.01	3137	0.21	7.1	C_4-S_3
Maximum	9.37	11.28	41	1.5	40.2	18.99	4.23	5740	0.39	12	C_4-S_4
4 Mean of 5 samples	4.39	7.45	15.14	0.76	13.91	9.46	2.91	2542	0.17	5.92	C_4-S_2
Maximum	5.78	10.1	22.2	1.11	21.7	10.9	4.25	3390	0.22	7.6	C_4-S_3
5 Mean of 5 samples	5.24	8.14	16.7	0.84	15.56	9.99	3.56	2881	0.19	6.3	C_4-S_2
Maximum	6.25	11.1	26.3	1.3	25.7	13.4	5	4340	0.26	8.5	C_4-S_3

Measurements are in equivalents per million (epm) unless otherwise indicated.
No Carbonate (CO_3) was found in these samples.
*The class was determined from the conductivity and sodium absorption ratio data according to the diagram for interpreting analysis of irrigation water. (U.S. Dept. of Agric. 1954)

Appendix Table 23 (cont.)

1963-64 SUMMARY OF CHEMICAL QUALITY WATER ANALYSIS IN THE STUDY AREAS

(Analysis by the Soil Conservation Service)

Wheeler Machinery Company Test Area

Sampling Station	Calcium	Magnesium	Sodium	Potassium	Chloride	Sulfate	Bicarbonate	Conductivity in micromhos at 25 C	Total dissolved solids %	Sodium Absorption Ratio	Class*
1 Mean of 5 samples	1.39	1.3	1.1	0.15	0.58	0.44	3.33	405	0.025	0.87	C_2-S_1
Maximum	2.24	2.13	1.22	0.36	0.75	0.64	4.08	473	0.031	1	C_2-S_1
2 Mean of 5 samples	3.1	1.71	2.3	0.18	1.11	0.59	5.31	634	0.040	1.62	C_2-S_1
Maximum	3.49	2.24	2.88	0.37	1.3	0.83	5.93	722	0.052	2.7	C_2-S_2
3 Mean of 4 samples	1.38	0.87	0.57	0.17	0.51	0.41	2.37	246	0.019	0.52	C_1-S_1
Maximum	2.84	1.54	0.90	0.40	0.86	0.71	3.89	512	0.030	0.60	C_2-S_1
4 Mean of 5 samples	1.3	1.42	2.33	0.2	1.17	0.57	3.51	479	0.029	1.72	C_2-S_1
Maximum	1.72	1.8	3.1	0.36	1.56	0.71	4.18	566	0.037	2.4	C_2-S_1

Measurements are in equivelants per million (epm) unless otherwise indicated.
No Carbonate (CO_3) was found in these samples.
*The class was determined from the conductivity and sodium absorption ratio data according to the diagram for interpreting analysis of irrigation water. (U.S. Dept. of Agric. 1954)

Appendix Table 24

1963-4 CHEMICAL QUALITY DATA FROM STREAMS FLOWING INTO THE STUDY AREA

Extracted from Geological Survey Records

Data	Jordan River 21st South S.L.C.		Jordan River Below Cudahy Lane		Surplus Canal Cohn's Slough		State Canal Farmington Bay
	Mean 9 samples	Maximum	Mean 10 samples	Maximum	Mean 2 samples	Maximum	1 sample
Mean daily discharge in cfs	212	341	106	120	234	331	92
Silica (SiO_2)	20	23	19	21	8	10	15
Iron (Fe)	-	-	-	-	-	-	-
Calcium (Ca)	138	152	124	147	78	92	109
Magnesium (Mg)	70	80	63	78	50	75	95
Sodium (Na)	203	220	180	215	144	208	470
Potassium (K)	-	-	0.6	6.2	-	-	-
Bicarbonate (HCO_3)	266	304	260	301	177	200	294
Carbonate (CO_3)	0	0	0	0	0	0	0
Sulfate (SO_4)	411	515	359	491	269	385	448
Chloride (Cl)	397	326	257	320	204	302	690
Flouride (F)	-	-	0.03	0.3	-	-	0.8
Nitrate (NO_3)	8.7	11	9.7	13	2.2	3.8	3.7
Boron (B)	-	-	0.02	0.15	-	-	0.48
Dissolved solids	1282	1390	1149	1350	843	1180	2030
Hardness as $CaCO_3$ Calcium, Magnesium	632	702	569	672	400	540	664
Non-carbonate	411	539	356	487	255	376	423
Sodium absorption ratio	3.5	3.9	3.4	3.5	3.1	3.9	7.9
Specific conductance in micromhos at 25° C	1948	2100	1779	2010	1342	1830	3230
Class	C_3-S_1	C_3-S_1	C_3-S_1	C_3-S_1	C_3-S_1	C_3-S_1	C_4-S_3
pH		8.5		8.1		7.6	7.5
Temperature F	50	62.5	50	77	56	60	34

*Measurements are in parts per million (ppm) unless otherwise indicated.

Appendix Table 25

1962-1965 WEATHER SUMMARY

	Temperature					Precipitation	
	Month	Mean Max.	Mean Min.	Average	Deviation from Normal	Total	Deviation from Normal
1962	Jan.	29.1	11.8	20.5	-7.7	0.84	-0.51
	Feb.	38.7	24	31.4	-1.6	1.43	0.25
	Mar.	45.9	24.3	35.1	-5.3	2.34	0.78
	Apr.	66.5	39.1	52.8	2.9	2.98	1.22
	May	71.2	46.1	58.7	0.3	2.12	0.72
	June	84.3	52.0	68.7	1.8	0.49	-0.49
	July	99	50	75.9	-0.5	2.52	1.94
	Aug.	101	38	73.1	-1.4	0.25	-0.61
	Sept.	83	48.6	65.8	0.9	0.27	-0.26
	Oct.	69.4	41.2	55.3	2.6	0.93	-0.22
	Nov.	53.6	29.6	41.6	3.4	0.44	-0.86
	Dec.	37.5	19.2	28.4	-3.2	0.28	-0.95
1963	Jan.	31.3	7.7	19.5	-8.7	0.53	-0.82
	Feb.	50.1	27.1	38.6	5.6	0.67	-0.51
	Mar.	51.1	27.7	39.4	-1.0	2.11	0.55
	Apr.	54.9	34.1	44.5	-5.4	3.86	2.10
	May	75.5	45.9	60.7	2.3	0.23	-1.17
	June	77.5	49	63.3	-3.6	1.67	0.69
	July	94.8	61.1	78	1.7	0.00	-0.58
	Aug.	91.5	64.3	77.9	3.4	0.54	-0.33
	Sept.	82.6	53	67.8	2.9	1.08	0.55
	Oct.	71.4	44.2	57.8	5.1	1.05	-0.1
	Nov.	48.9	28.9	38.9	0.7	1.56	0.26
	Dec.	32	16.7	24.4	-7.2	0.79	-0.45
1964	Jan.	30.8	11.9	21.9	-5.3	0.94	-0.41
	Feb.	35.6	15.9	25.8	-6.7	0.35	0.83
	Mar.	41.7	22.2	32.0	-8.4	2.26	0.7
	Apr.	56.8	34.3	45.6	-4.3	2.69	0.93
	May	69.2	42.4	55.8	-3.1	2.77	1.37
	June	75.4	50	63.2	-4.2	2.61	1.63
	July	94.6	60.1	77.5	0.6	0.26	-0.32
	Aug.	88.2	55.6	71.9	-2.6	0.17	-0.70
	Sept.	79.2	43.8	61.5	-2.9	0.13	-0.40
	Oct.	69.8	36.1	53	1.3	0.45	-0.70
	Nov.	47.8	27.7	37.8	1.1	1.42	0.12
	Dec.	41.1	25.5	33.3	3.2	3.82	2.59
1965	Jan.	38.5	23.5	31	3.8	2.13	0.78
	Feb.	43.7	22.3	33	0.5	1.13	-0.05
	Mar.	49.4	24.1	36.8	3.6	0.14	-1.42
	Apr.	62.9	39.1	51	1.1	2.3	0.54
	May	67.9	41.5	54.7	-4.2	2.02	0.62
	June	79.9	49.7	64.8	-2.6	1.87	0.89
	July	89.9	60	75	-1.9	1.50	0.92
	Aug.	85.5	56.3	70.9	-3.6	2.08	1.21
	Sept.	70.8	44.2	57.5	-6.9	1.93	1.40

Total yearly precipitation as follows: 1962, 14.9; 1963, 14.09; 1964, 17.87; 1965, 15.10 (January--September only)

(Data obtained from U.S. Weather Bureau Monthly Meterological summaries, Salt Lake City, Utah (Airport Station). Climatological standard normals based on period 1930-1960, effective January, 1962.)

Appendix Table 26. Summary of Weather Data From Farmington Bay Evaporation Station

Month	No. of Measurements	Average Daily Temp.				Total Wind in Miles	Computed Evaporation in Inches	
		Air		Water				
1964		Max.	Min.	Max.	Min.		Total	Mean per Day
May	19	72.0	44.5	74.5	50.0	846	3.642	.192
June	27	79.5	50.5	79.0	52.0	761	4.334	.161
July	21	81.0	70.5	83.5	68.5	29*	5.461***	.260
August	29	83.0	54.5	83.0	53.0	489**	6.619***	.228
Sept.	25	73.5	51.0	71.5	57.5	1,133	5.138	.206
1965								
June	28	73.0	55.5	74.0	57.5	1,346	7.680	.274
July	28	83.0	68.5	80.5	66.5	1,355	6.784	.242
August	30	79.0	54.0	79.5	61.5	1,211	6.354	.212
Sept.	23	68.0	41.5	71.0	41.0	931	3.110	.135

[1] This data was summarized from records of the U.S. Weather Bureau, Hydrology Section, Salt Lake City, Utah

* Measurements recorded for only 2 days

** Measurements recorded for only 12 days

*** Computations based on zero wind for days when wind measurements were not taken. The actual evaporation is probably higher than this.

MARSH DEVELOPMENT

Figure 8

1. Dike construction on the Lake Front Gun Club impounds water for marsh development.

2. Water level in the impoundment is controlled by an adjustable spillway, spanned by a roadway bridge.

3. Wide weirs with adjustable flash boards are essential for adequate water control.

4. In a dike a wheel operated water gate requires frequent adjustment to preserve the culvert and dike.

5. A submerged culvert too small to receive the volume of water creates the whirlpool and accompanying flooding.

6. Inadequate water control structures result in water flooding over a road on a retaining dike.

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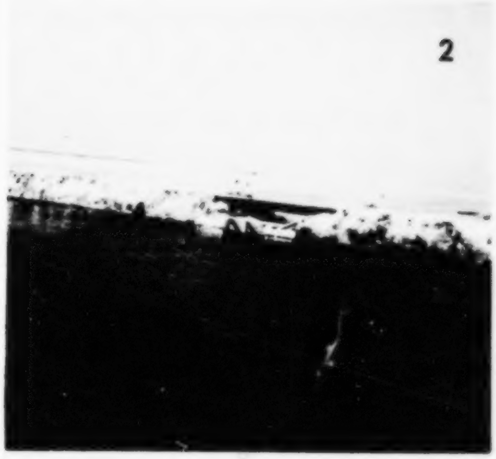

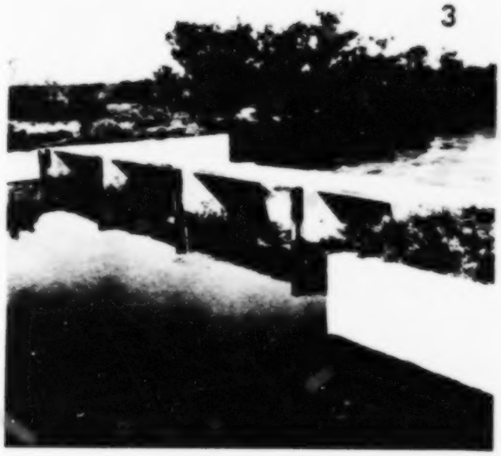

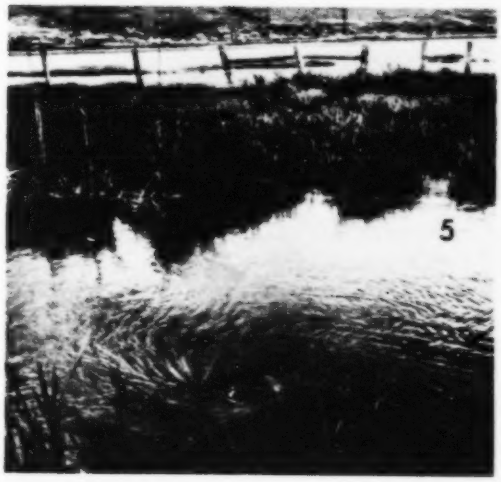

Figure 8 (continued)

1. Dikes when first constructed are without vegetation and are vulnerable to erosion.

2. Dikes later are protected by vegetation and a road accommodates vehicular travel for dike maintenance and marsh management.

3. Planted sweet clover provides rapid vegetative protection for a dike and cover and food for wildlife.

4. Tall wheat grass grows well in alkali soils and shares the same function as clover.

5. Planted and irrigated crops such as Japanese millet flourishes in some marshland and provides food for waterfowl.

6. A flourishing marsh of indigenous vegetation. Salt grass in the foreground, alkali bulrush in the middle and olney's bulrush and cattail in the background.

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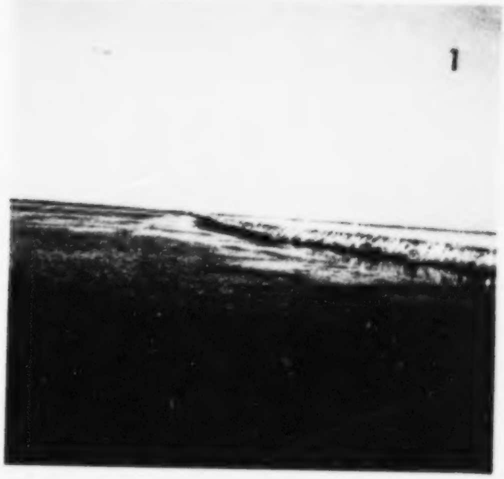
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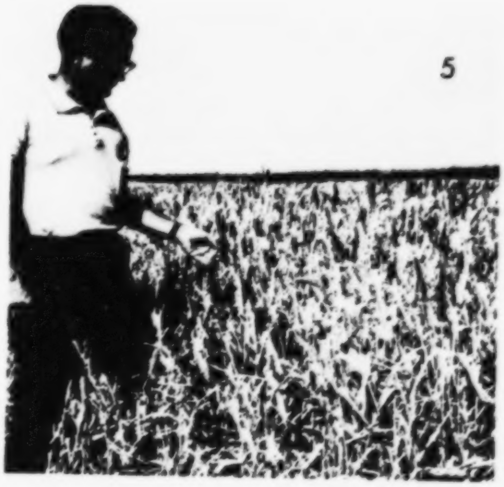
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